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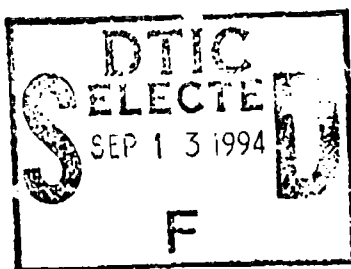


DOT/FAA/RD-93/31,II

Research and Development
Service
Washington, DC 20591

**Rotorwash Analysis
Handbook**

Volume II - Appendixes



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June 1994

Final Report

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U.S. Department of Transportation
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Technical Report Documentation Page

1. Report No. DOT/FAA/RD-93-31, II		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Rotorwash Analysis Handbook, Volume II: Appendixes				5. Report Date June 1994	
				6. Performing Organization No.	
7. Author (s) Samuel W. Ferguson, EMA				8. Performing Organization Report No. SCT No. 93RR-17	
9. Performing Organization Name and Address: Systems Control Technology, Inc. 1611 North Kent Street, Suite 910 Arlington, VA 22209				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. DTFA01-87-C-00014	
12. Sponsoring Agency Name and Address Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591				13. Type Report and Period Covered Final Report	
				14. Sponsoring Agency Code ARD-30	
15. Supplementary Notes 1. Work was performed under Subcontract T-2608-002 by EMA, Mansfield, TX 2. ARD-30 Vertical Flight Program Office					
16. Abstract Documentation, a program listing, and a user's guide are provided for version 2.1 of the FORTRAN 77-based ROTWASH computer program in report appendices. An extensive bibliography of rotorwash related technical documents is also provided. This listing is subdivided into different rotorwash topics. A companion report, entitled "Evaluation of Rotorwash Characteristics for Tiltrotor and Tiltwing Aircraft in Hovering Flight," DOT/FAA/RD-90/16, evaluates rotorwash characteristics of 11 different types of tiltrotor and tiltwing aircraft for comparison purposes. Another companion report, entitled "Analysis of Rotorwash Effects in Helicopter Mishaps," DOT/FAA/RD-90/17, presents an analysis of several of the more common types of rotorwash related helicopter mishaps. Much of the information provided in this second companion report is updated by this report. A third report, DOT/FAA/RD-90/25, "Rotorwash Computer Model - User's Guide," is replaced by this more comprehensive report and its updated version of the ROTWASH computer program.					
17. Key Words Heliports Airport Planning Heliport Design Downwash Rotorcraft Ground Effects (Aerodynamics) Rotor Downwash Helicopters				18. Distribution Statement This document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 193	
22. Price					

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APPENDIX A
ROTORCRAFT DESIGN DATA IN ROTWASH FORMAT

TABLE A-1 ROTORCRAFT DATA SUMMARY

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (gct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Aerospatiale								
SA341G	3,970	17.25	1.5	4.24	1/3	683	8.9	--
SA342L	4,410	17.25	1.5	4.73	1/3	698	8.9	--
AS350B	4,299	17.55	2.0	4.44	1/3	698	10.3	--
AS550	4,960	17.55	2.0	5.12	1/3	698	10.3	--
AS555	5,600	17.55	2.0	5.79	1/3	698	10.3	--
AS355	5,291	17.55	2.0	5.47	1/3		10.7	--
SA115B	5,070	18.05	1.5	4.95	1/3		10.1	--
SA119H	4,960	18.05	1.5	4.84	1/3		9.8	--
SA360	6,615	18.85	2.0	5.92	1/4	690	11.5	--
SA365N	8,900	19.55	2.0	7.41	1/4	715	11.4	--
AS365	9,370	19.58	2.0	7.78	1/4	717	11.4	--
SA330	16,315	24.75	5.0	8.48	1/4	687	14.4	--
AS332 MK.I	19,840	25.60	5.0	9.64	1/4	711	15.0	--
AS332 MK.II	20,944	26.58	5.0	9.43	1/4		16.3	--
SA321	28,660	31.00	5.0	9.49	1/6	688	16.3	--
Agusta								
A109A	5,732	18.05	1.5	5.60	1/4	727	10.0	--
A109C	5,996	18.05	1.5	5.86	1/4	727	10.0	--
A129	9,039	19.52	2.0	6.80	1/4		10.5	--

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Bell								
47	2,850	18.50	1.0	2.65	1/2	645-716	9.5	--
206	3,200	16.65	1.5	3.67	1/2	688	9.5	--
OH-58A	3,200	17.65	1.5	3.26	1/2	654	9.5	--
OH-58D	5,500	17.5	1.5	5.72	1/4	724	8.5	--
206L	4,150	18.5	1.5	3.86	1/2	763	10.1	--
222B	8,250	21.0	4.0	5.95	1/2	765	10.8	--
230	8,250	21.0	4.0	5.95	1/2	765	12.0	--
204	8,500	22.0	2.0	5.59	1/2	746	11.8	--
UH-1M	9,500	22.0	2.0	6.25	1/2	746	11.8	--
205	9,500	24.0	2.0	5.25	1/2	814	11.8	--
212	11,200	24.0	2.0	6.19	1/2	814	13.4	--
412	11,900	23.0	2.0	7.16	1/4	780	11.0	--
214B	13,800	25.0	2.0	7.03	1/2	785	14.0	--
214ST	17,500	26.0	2.0	8.14	1/2	781	14.2	--
AH-1S	10,000	22.0	2.0	6.51	1/2	746	12.3	--
AH-1T/W	14,750	24.0	2.0	8.15	1/2	781	13.5	--
XV-15	13,200	12.5	13.0	13.44	2/3	771	12.5	32.2
Bell/Boeing								
V-22	47,500	19.0	10.0	17.63	2/3	790	20.1	46.5

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Boeing/Vertol								
CH 16E	24,300	25.5	7.0	5.95	2/3	705	16.6	33.3
CH 47C	46,000	30.0	8.0	8.13	2/3	723	18.6	39.2
CH-47D	54,000	30.0	8.0	9.55	2/3	707	18.6	39.2
Enstrom								
F28F/28C	2,600	16.0	1.5	3.23	1/3		9.1	--
Kaman								
SH-2	12,800	22.0	2.0	8.42	1/4	687	13.6	--
MBE								
BO105CB	5,512	16.11	1.5	6.81	1/4	715	9.7	--
BO108	5,511	16.4	1.5	6.52	1/4		9.8	--
BK117	7,055	18.05	2.0	6.90	1.4	725	11.0	--
McDonnell Douglas								
30C	2,050	13.4	1.0	3.63	1/3	662	8.8	--
500D	3,000	13.2	1.5	5.48	1/4	665	8.5	--
500E	3,000	13.2	1.5	5.48	1/5	680	8.7	--
530F	3,100	13.7	1.5	5.28	1/5	684	8.7	--
AH-64	14,694	24.0	2.0	8.12	1/4	726	12.6	--
520N	3,350	13.67	1.5	5.71	1/5	684	8.7	--

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Robinson								
R22	1,370	12.6	1.0	2.75	1/2	699	8.8	--
R44	2,400	16.5	1.0	2.81	1/2		10.5	--
Rogerson/Hiller								
UH-12	2,800	17.7	1.0	2.84	1/2		10.1	--
FH-1100	2,850	17.7	1.5	2.91	1/2		9.5	--
Schweizer								
300C	4,050	13.4	1.0	3.63	1/3	662	8.8	--
330	2,050	13.4	1.5	3.63	1/3	662	9.2	--
Sikorsky								
S-62	7,900	26.5	5.0	3.58	1/3			--
S-76	10,300	22.0	3.0	6.77	1/4	675	10.0	--
S-76B/C	11,700	22.0	3.0	7.69	1/4	675	10.0	--
UH-60A	20,250	26.85	3.0	8.94	1/4	725	12.3	--
UH-60L	22,000	26.85	3.0	9.71	1/4	725	12.3	--
S-61	20,500	31.0	5.0	6.79	1/5		17.0	--
SH-3	20,500	31.0	5.0	6.79	1/5	660	15.5	--
CH-3E	22,500	31.0	5.0	7.45	1/5		16.2	--
CH-54A	42,000	36.1	5.0	10.23	1/6		18.6	--
S-64E	42,000	36.1	5.0	10.23	1/6		18.6	--
CH-54B	47,000	36.1	5.0	11.54	1/6	700	17.6	--

TABLE A-1 ROTORCRAFT DATA SUMMARY (Continued)

Rotorcraft Manufacturer/ Type	Maximum Gross Weight (lb)	Main Rotor Radius (ft)	Estimated Fuselage Download (Pct)	Rotor Disk Loading (psf)	Number of Rotors/Blades per Rotor	Rotor Tip Speed (fps)	Rotor Height Above Ground (ft)	Twin Rotor Separation (ft)
Sikorsky (Continued)								
CH-53D	36,400	36.1	5.0	8.89	1/6	700	17.0	--
HH-53	38,275	36.1	5.0	9.35	1/6		17.0	--
RH-53D	41,126	36.1	5.0	10.04	1/6		17.0	--
CH-53E	70,000	39.5	5.0	14.28	1/7	733	17.0	--
Westland								
Lynx	10,500	21.0	2.0	7.58	1/4		9.8	--
Lynx(3)	12,000	21.0	2.0	8.66	1/4		10.0	--
W-30-200	12,800	21.8	2.0	8.57	1/4	745	12.5	--
W-30-300	15,500	21.8	2.0	10.38	1/4			--
EH-101	31,500	30.5	5.0	10.78	1/5		21.3	--
SEA KING	21,500	31.0	5.0	7.12	1/5	660	15.5	--
MIL (Soviet)								
MI-8	26,455	34.93	5.0	6.90	1/5		16.0	--
MI-14	30,865	34.93	5.0	8.05	1/5		22.0	--
MI-17	28,660	34.93	5.0	7.48	1/5		15.5	--
MI-26	123,450	52.50	5.0	14.26	1/8	725	26.0	--
MI-34	2,976	16.41	2.0	3.52	1/4			--

APPENDIX B
SIKORSKY CH-53E HELICOPTER AND ROTORWASH DATA

Sikorsky CH-53E helicopter characteristics used with the ROTWASH analysis program are listed in table B-1 as obtained from reference B-1. Figure B-1 presents a three-view drawing of the helicopter. Table B-2 provides a summary tabulation of parameters defining the conditions for all rotorwash data presented in this appendix. Flight test data used in correlation with the ROTWASH calculated data are obtained from reference 2 and were measured along the 270-degree azimuth (out the left side of the helicopter). Distance from rotor center (DFRC), gross weight (GW), and rotor height above ground level (RHAGL) are the primary independent variables for these measured data. Discussion of results is presented in section 3.1 of this report.

REFERENCES

- B-1. Prouty, R.W., Helicopter Performance, Stability, and Control, Robert E. Krieger Publishing Company, Malabar, FL 32950, 1990.
- B-2. Harris, D.J., and R.D. Simpson, "CH-53E Helicopter Downwash Evaluation," Naval Air Test Center Technical Report No. SY-89R-78, August 1, 1978.

TABLE B-1 CH-53E ROTWASH INPUT DATA

<u>Parameter</u>	<u>Value</u>
Rotor radius, feet	39.5
Distance between rotor centers, feet	0.0
Airframe download, percent of rotor thrust	5.0
Distance from wheels to rotor plane, feet	17.0
Rotor speed, RPM	177.0
Rotor tip speed, feet/second	732.0
Number of rotor blades per rotor	7
Density ratio	1.0

**TABLE B-2 EVALUATION MATRIX FOR CH-53E FLIGHT TEST
MATHEMATICAL MODEL DATA CORRELATION**

FIGURE NUMBER	GROSS WEIGHT (lb)	DISK LOADING (lbs/ft ²)	ROTOR HEIGHT (feet)	DISTANCE FROM ROTOR CENTER (DFRC) (feet)
B-2	70,000	14.28	37.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-3	70,000	14.28	77.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.9
B-4	70,000	14.28	117.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-5	56,000	11.42	37.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-6	56,000	11.42	77.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-7	56,000	11.42	117.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-8	45,000	9.18	37.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-9	45,000	9.18	77.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8
B-10	45,000	9.18	117.0	31.6, 39.5, 49.4, 59.3, 69.1, 79.0, 118.5, 177.8

NOTES:

- 1) The values of DFRC are only applicable along the 270-degree azimuth.
- 2) Ambient winds varied between 0 and 3.5 knots.
- 3) Atmospheric density ratio was assumed equal to 1.0 since pressure altitude (which was near sea level) was not documented in reference B-2. Ambient temperature was measured from 39 to 45 degrees Fahrenheit during testing.

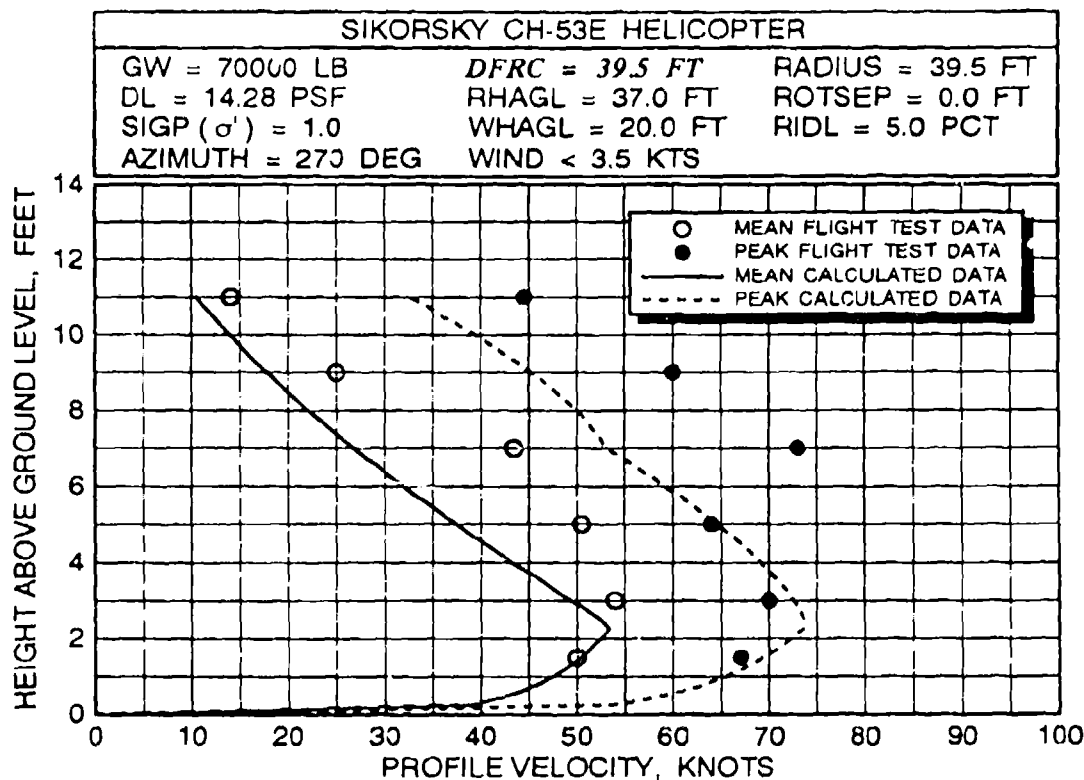
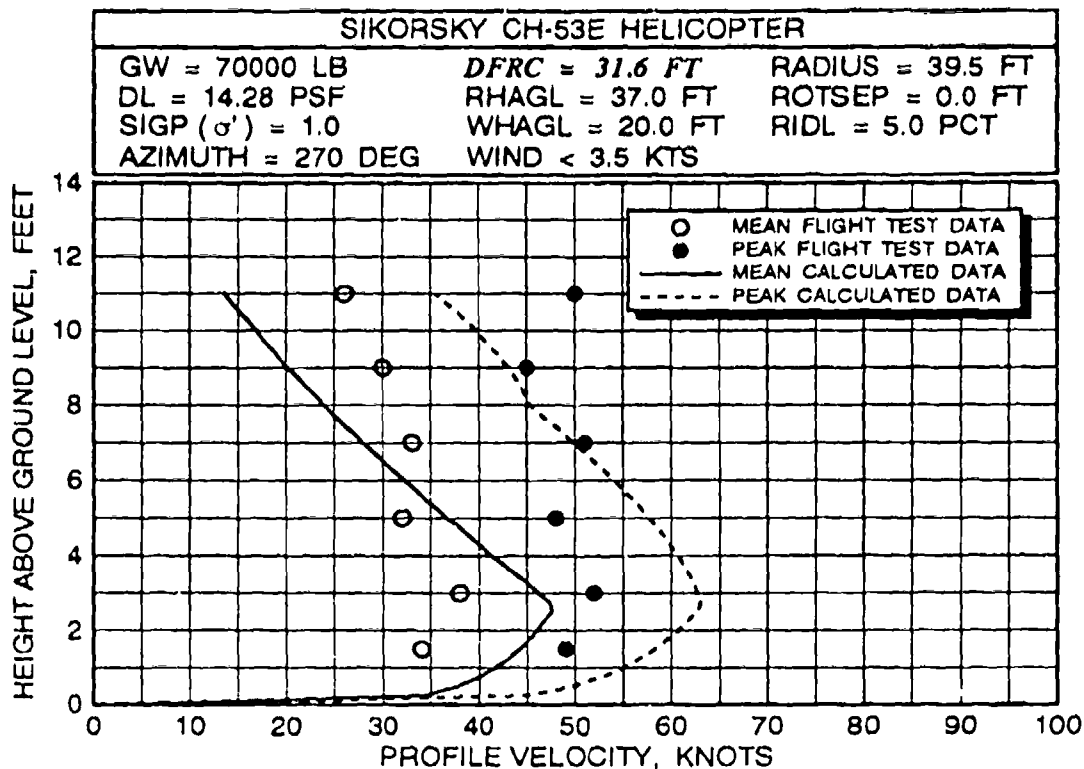


FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS

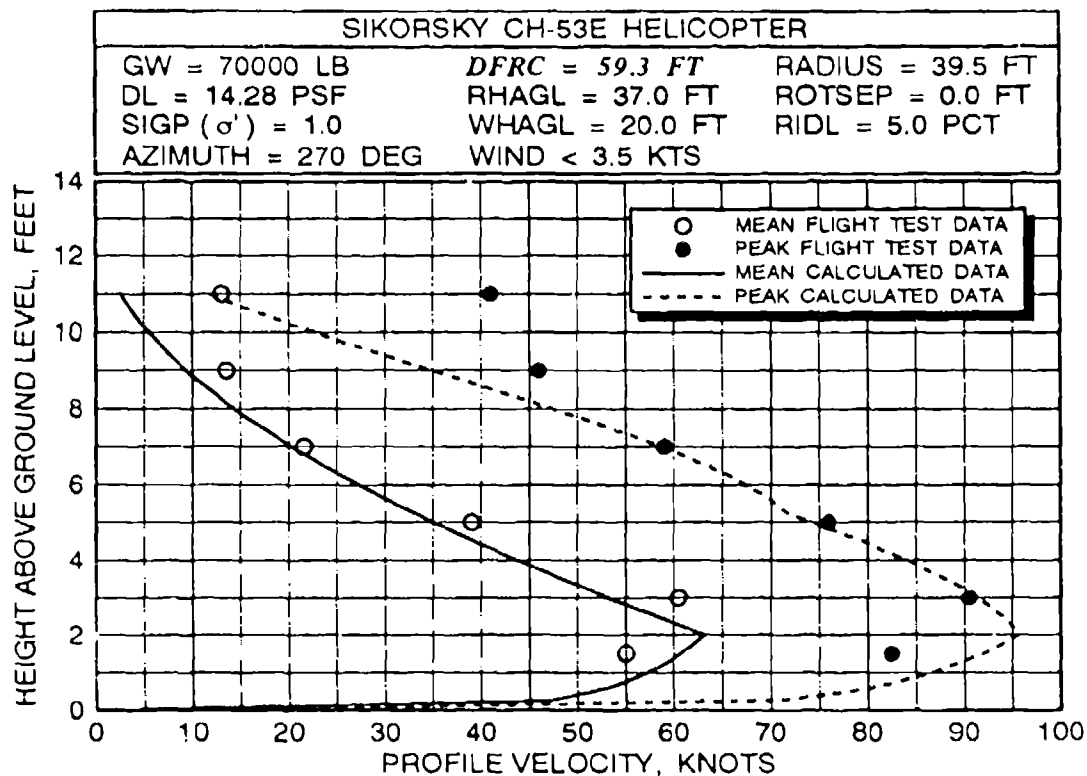
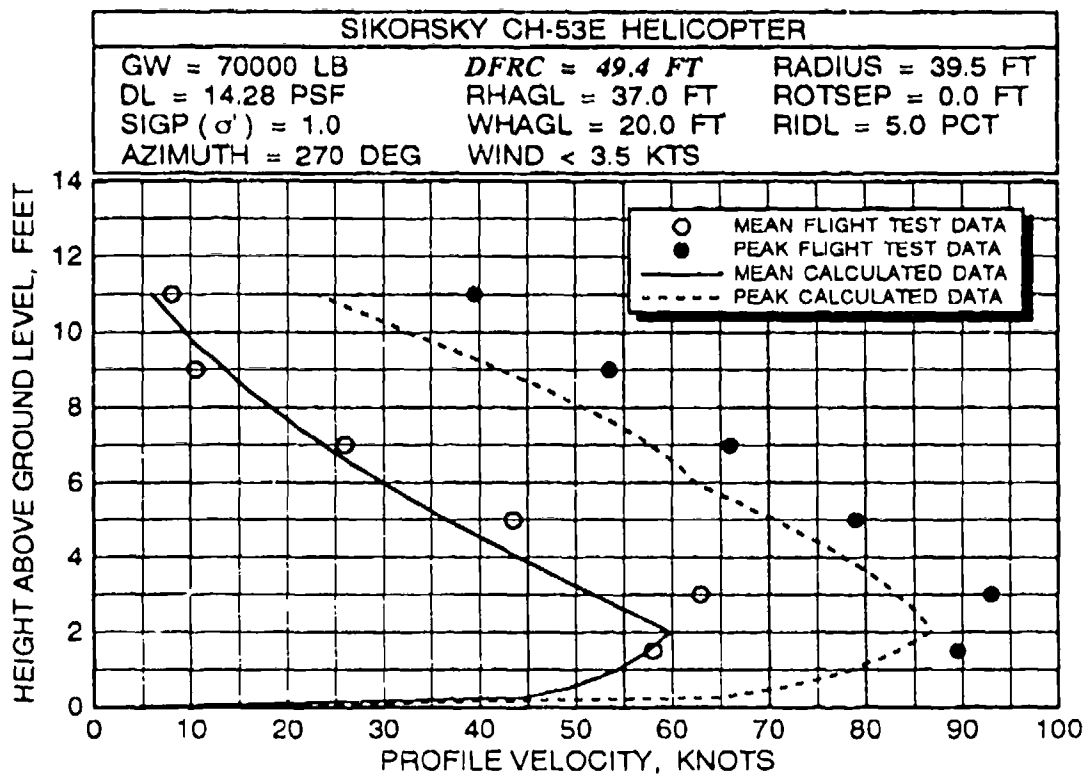


FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

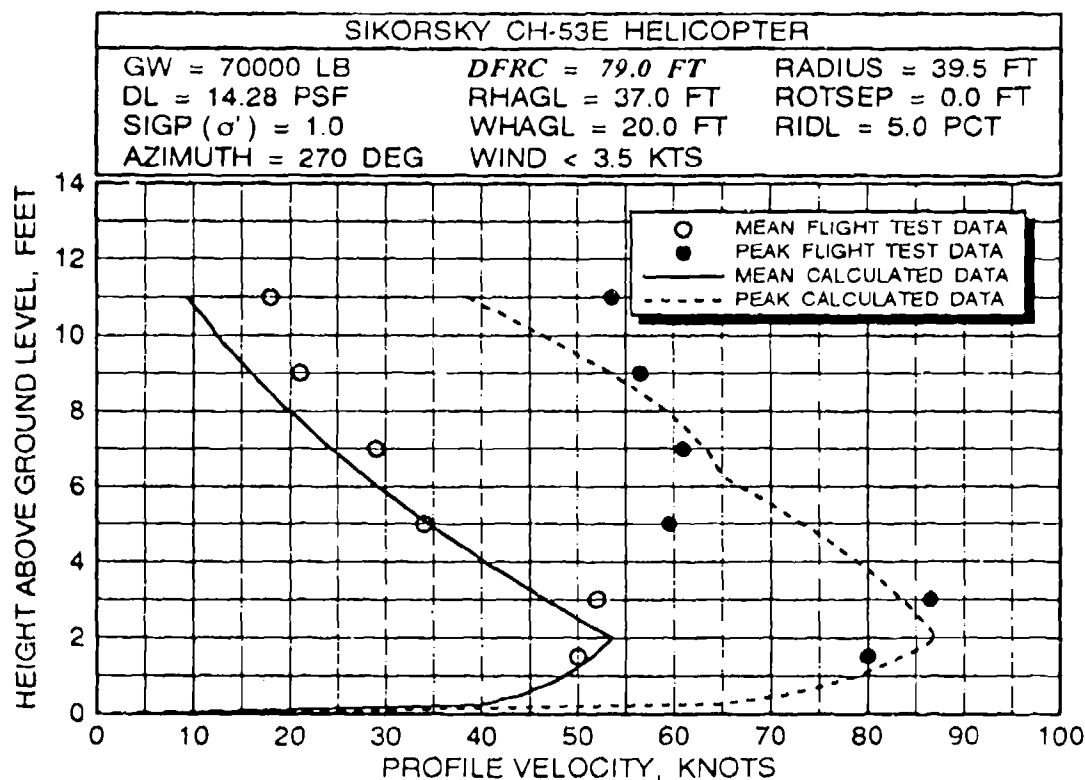
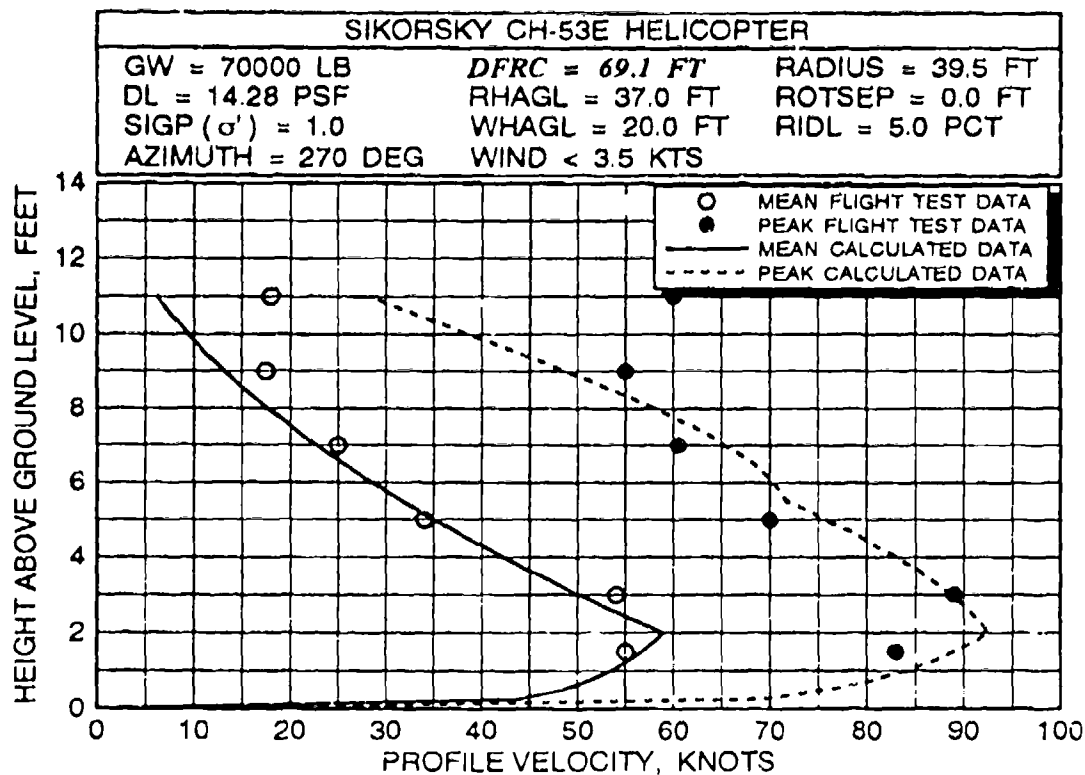
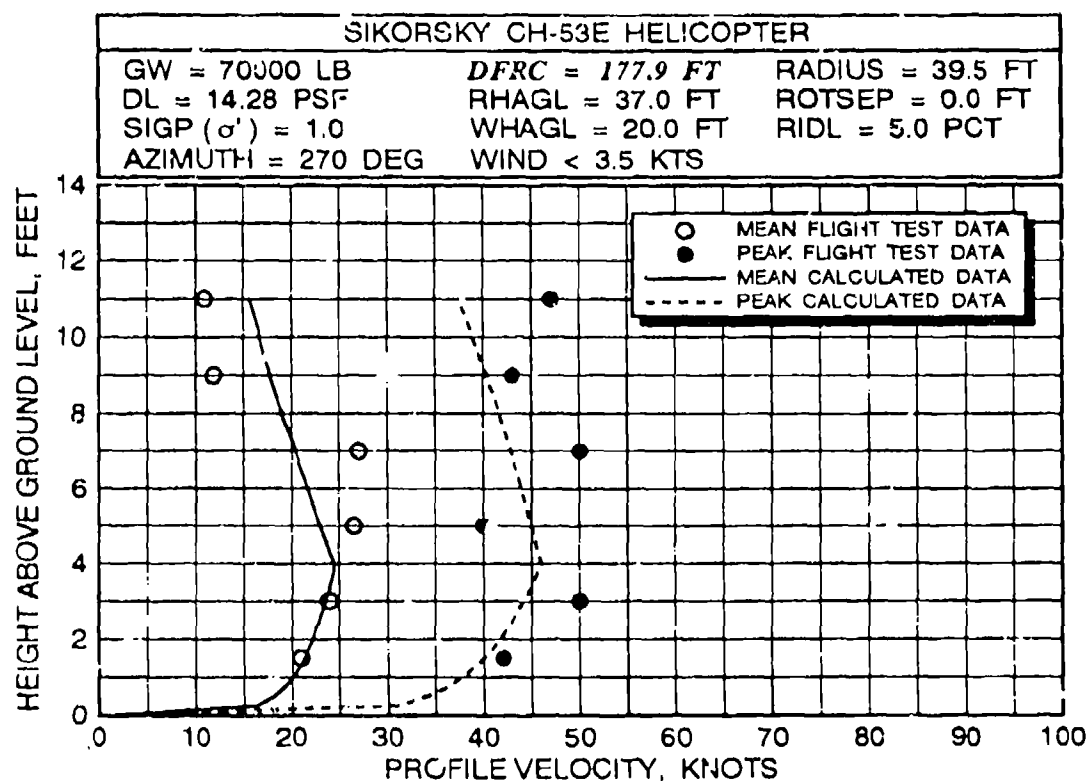
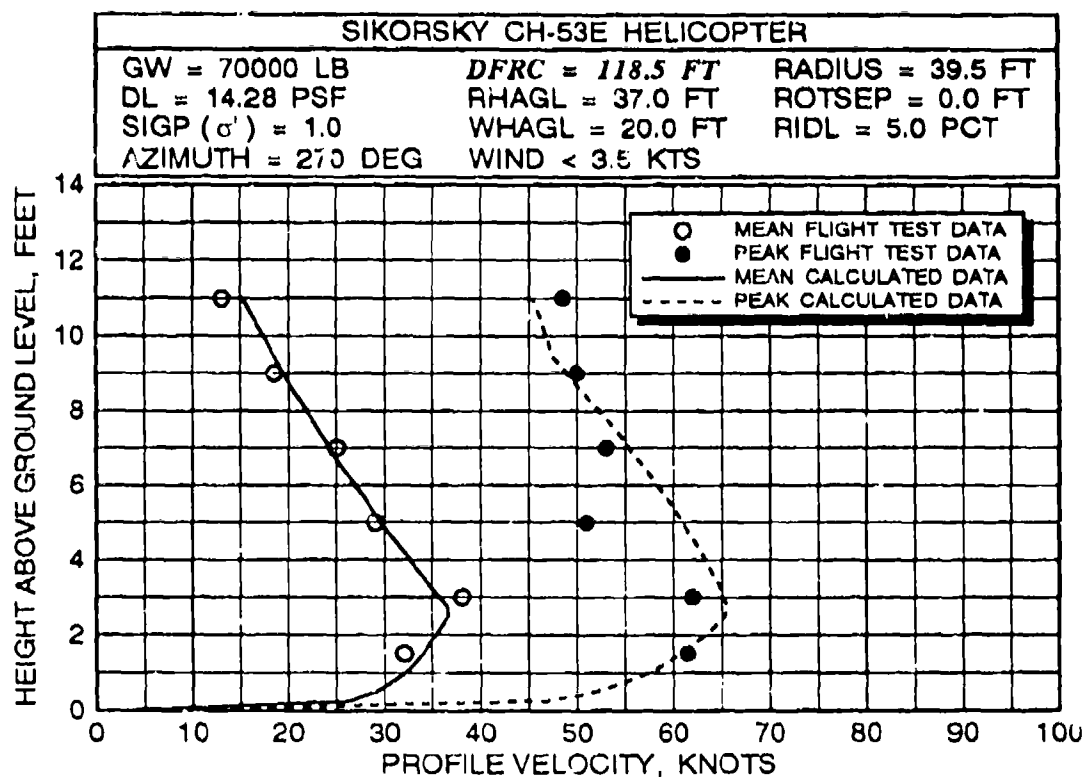


FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)



**FIGURE B-2 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT
270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT
OF 37 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)**

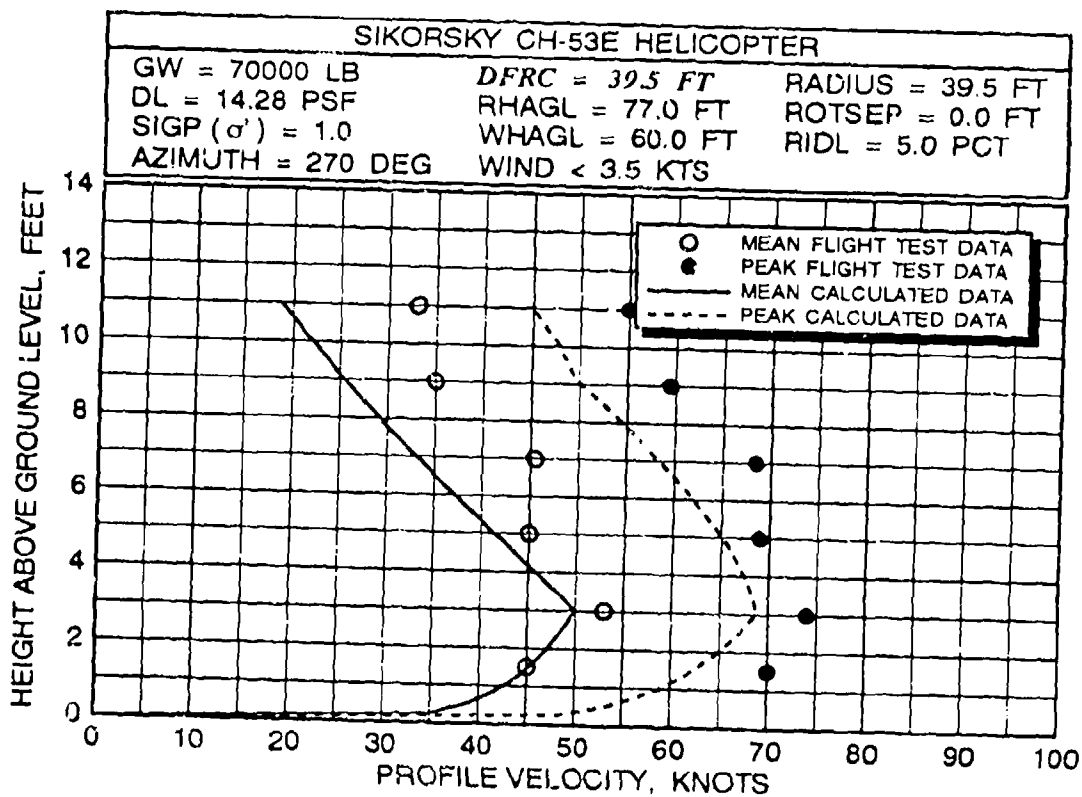
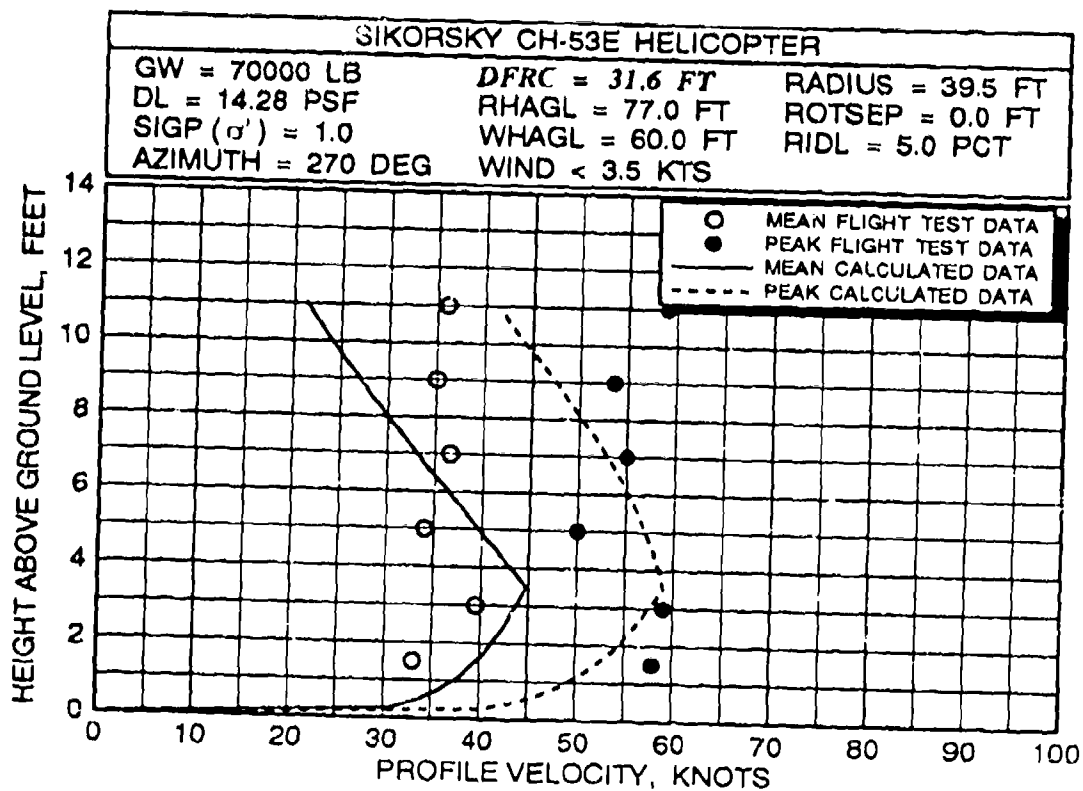


FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS

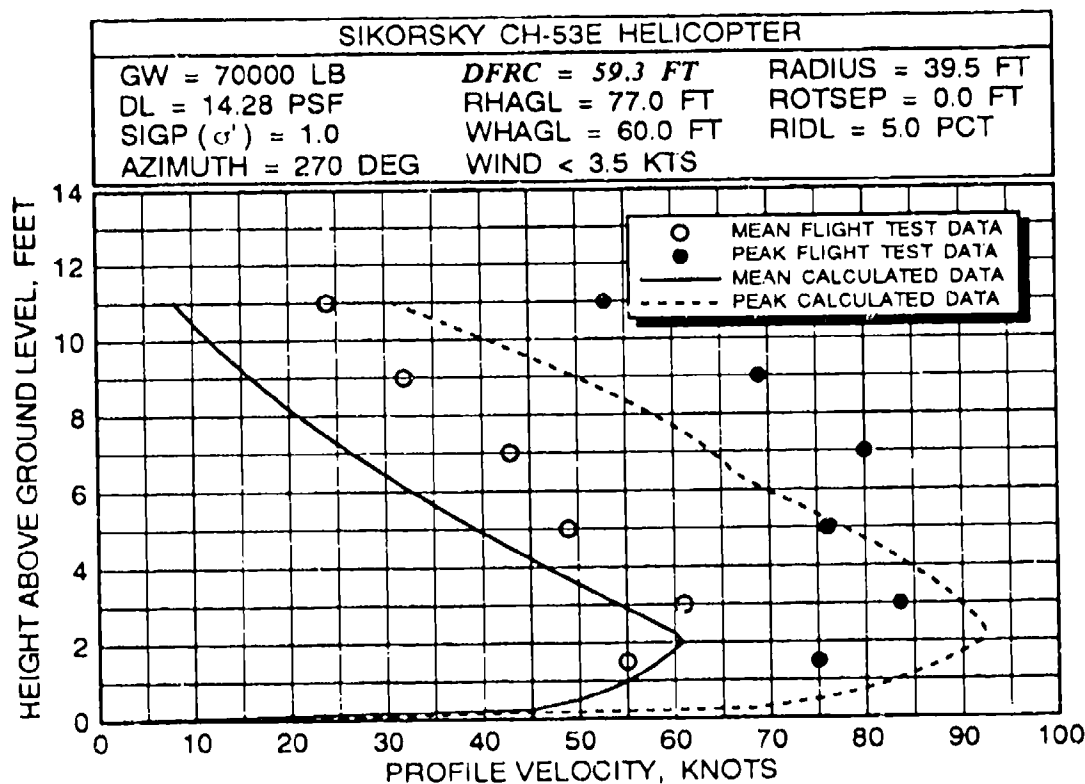
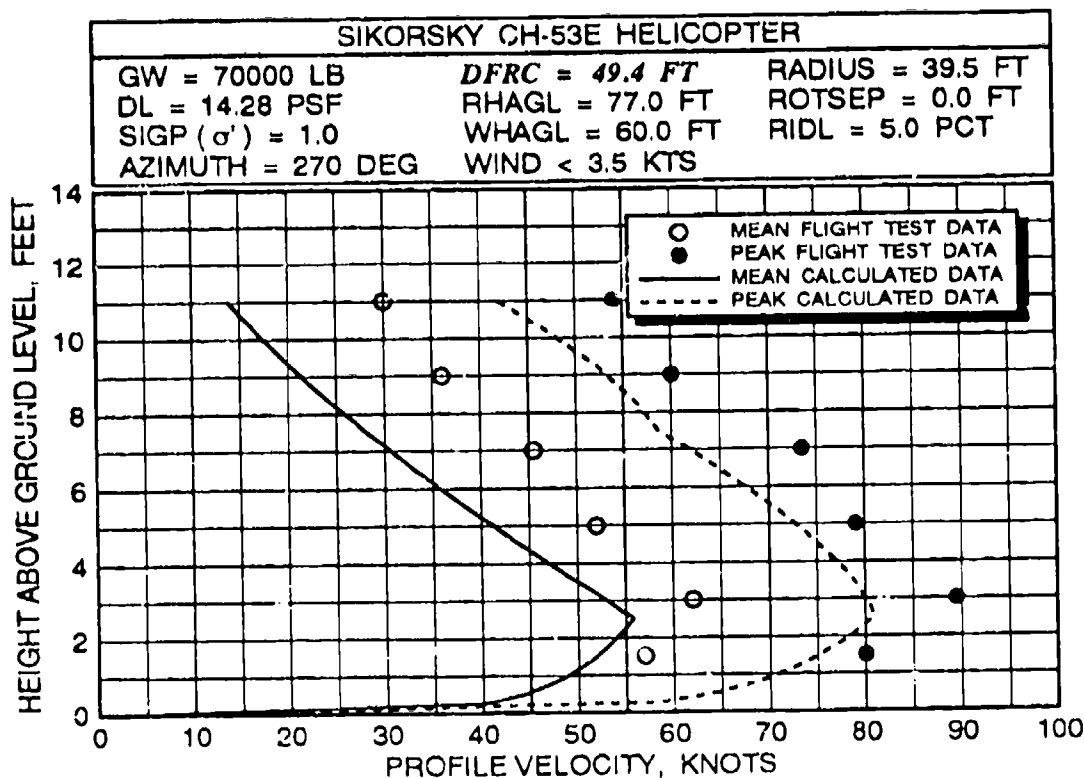


FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

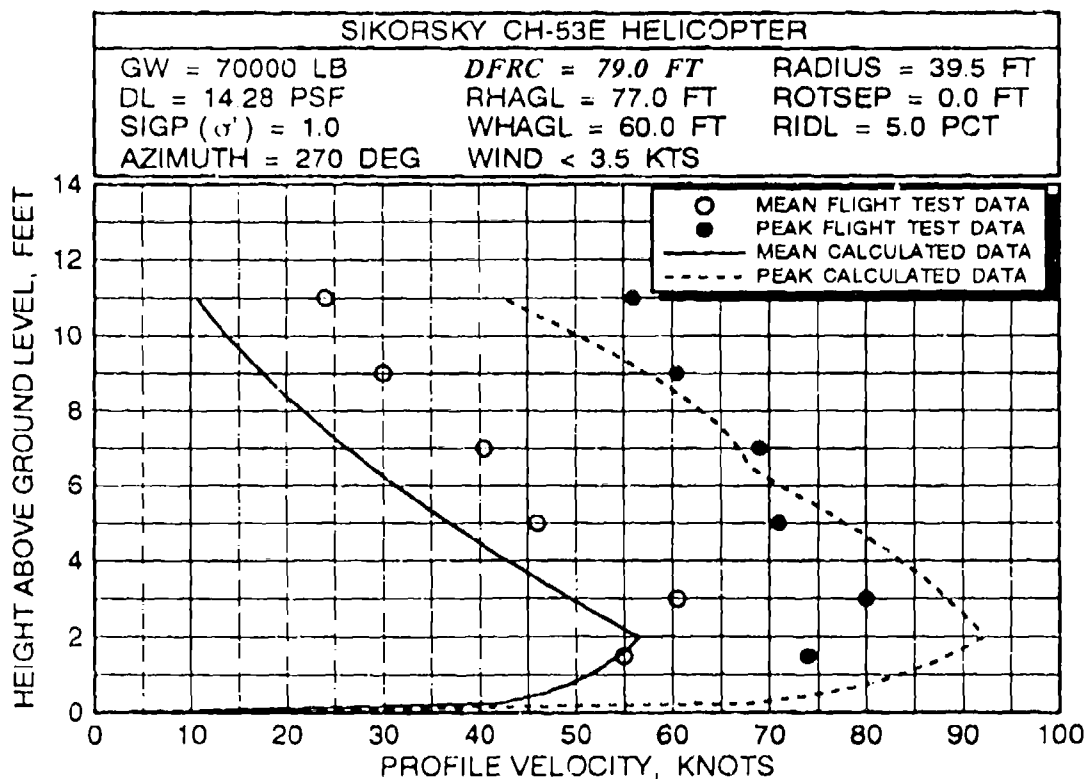
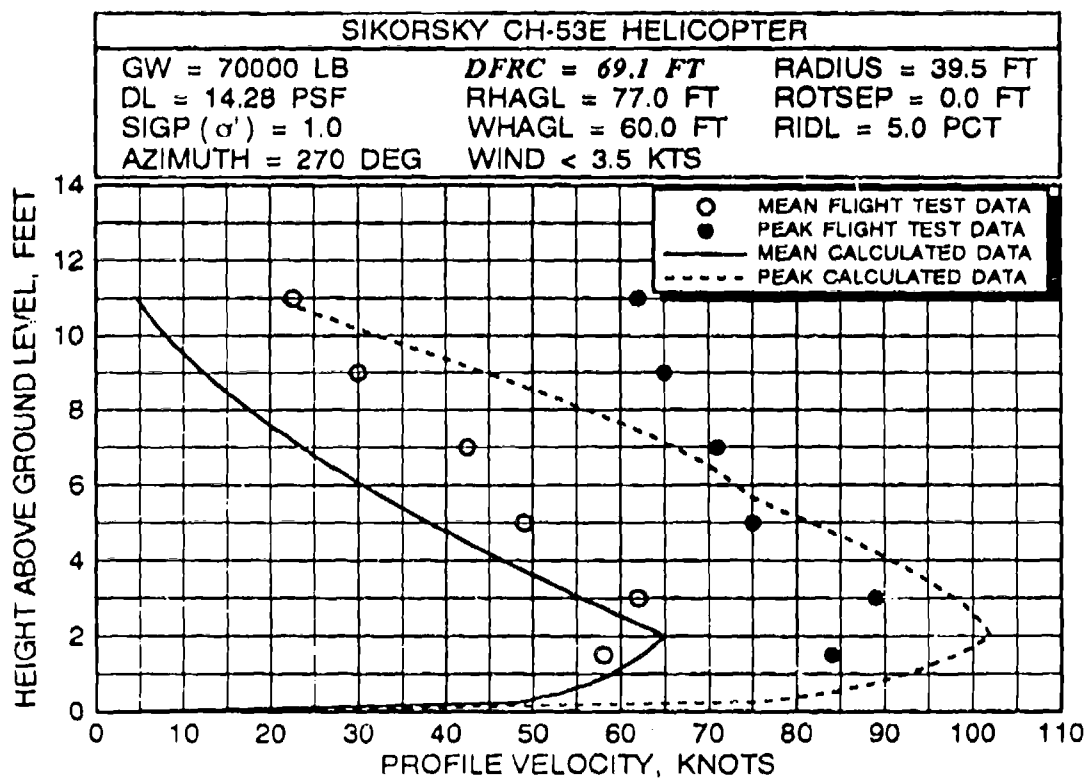


FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

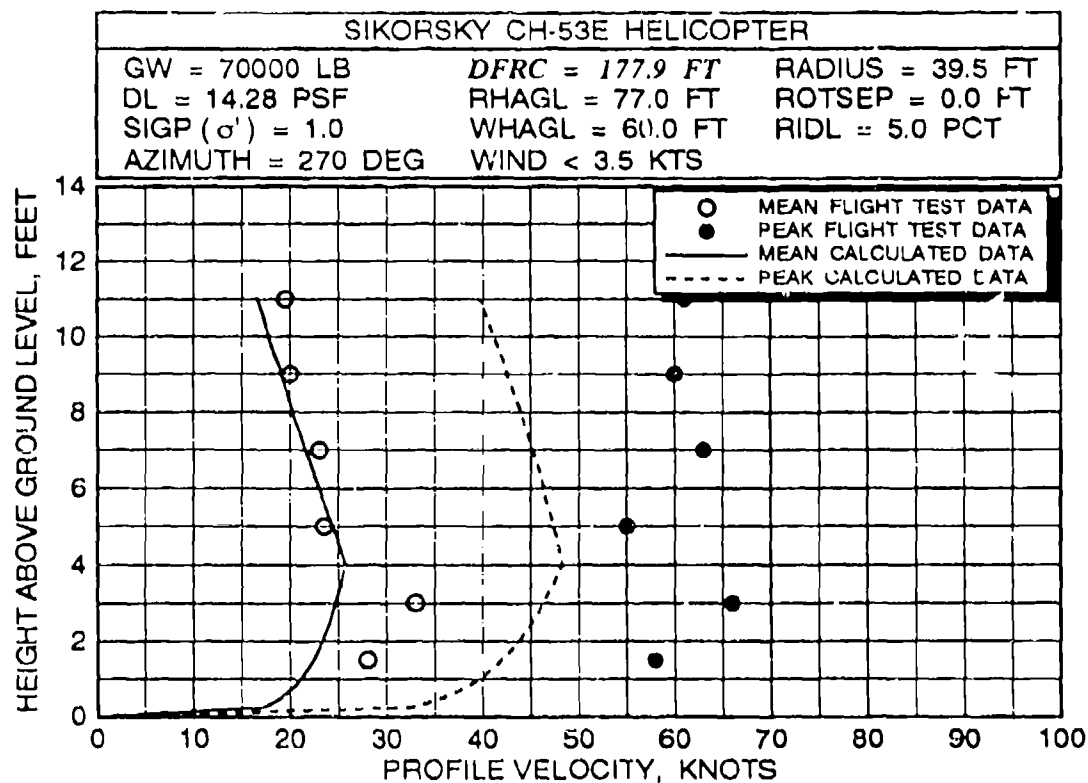
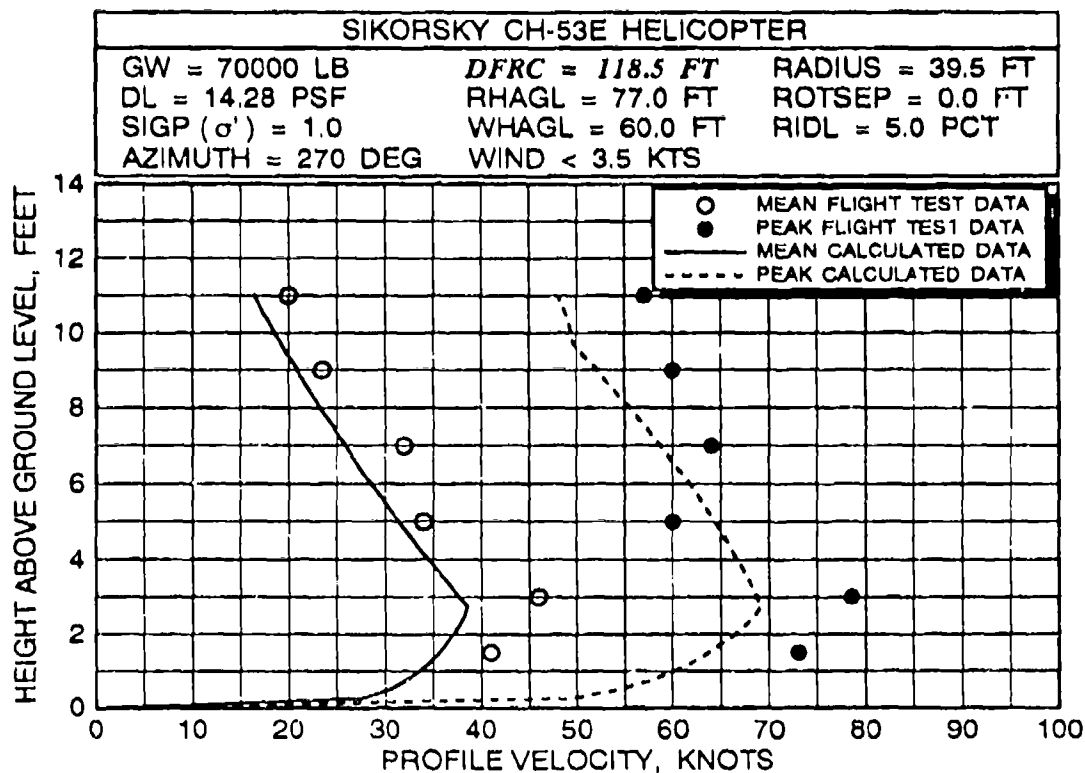


FIGURE B-3 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

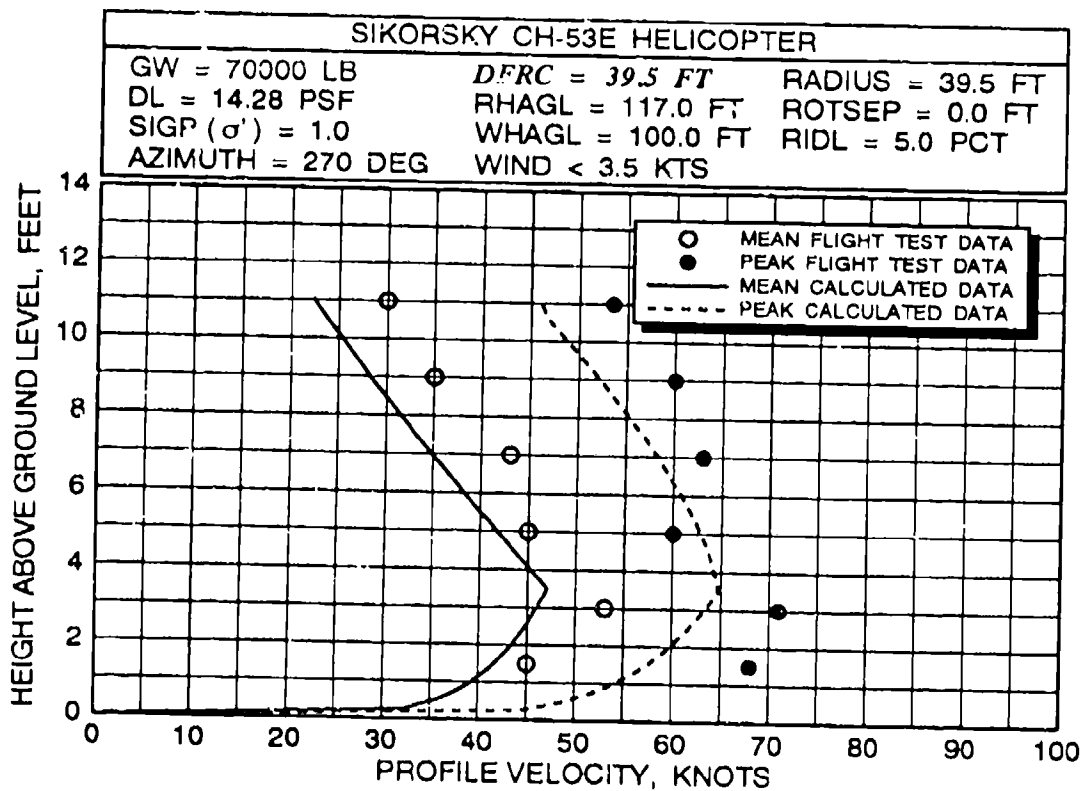
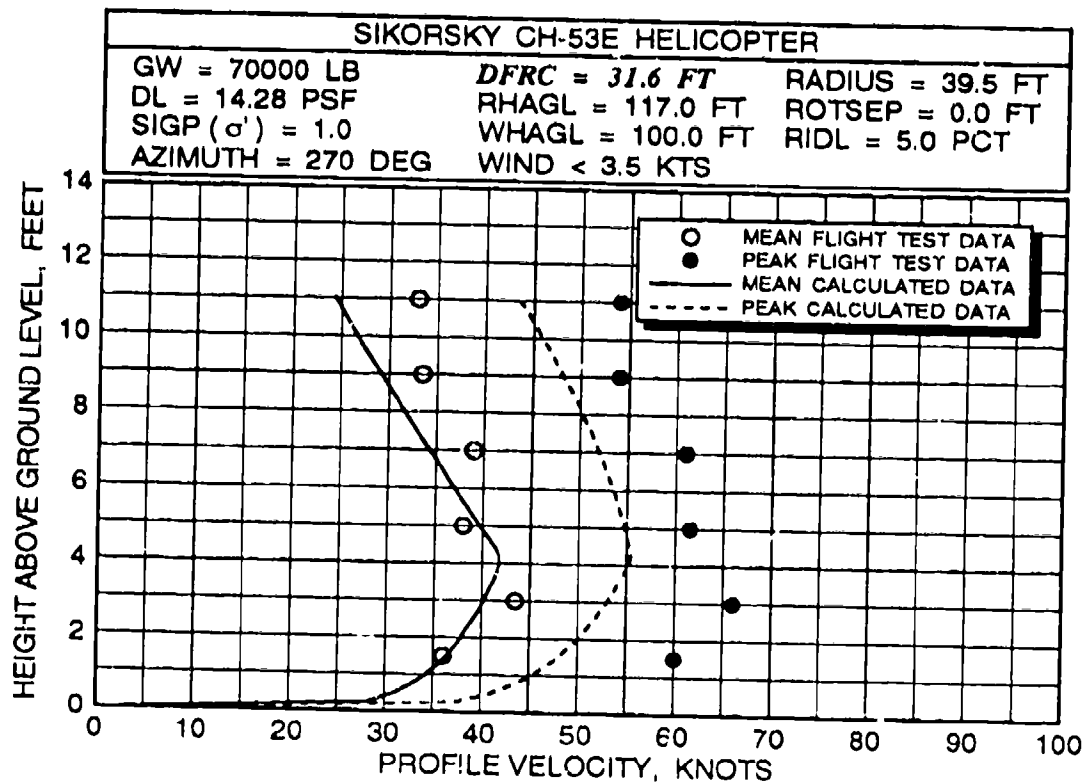


FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS

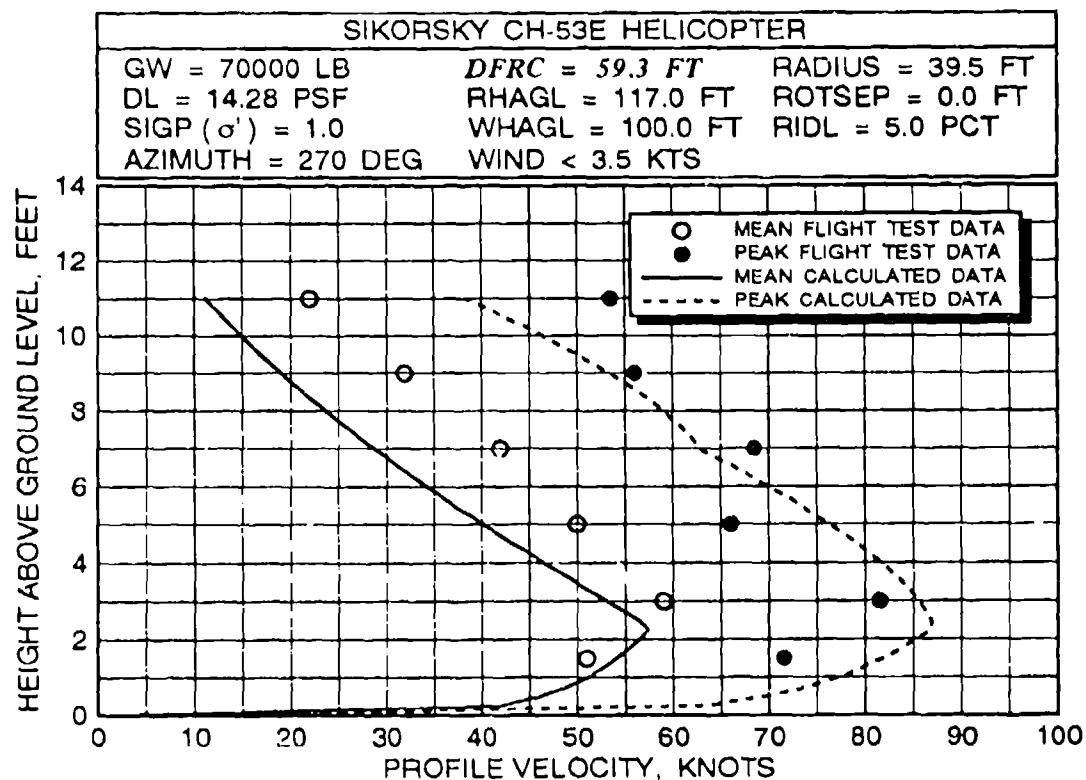
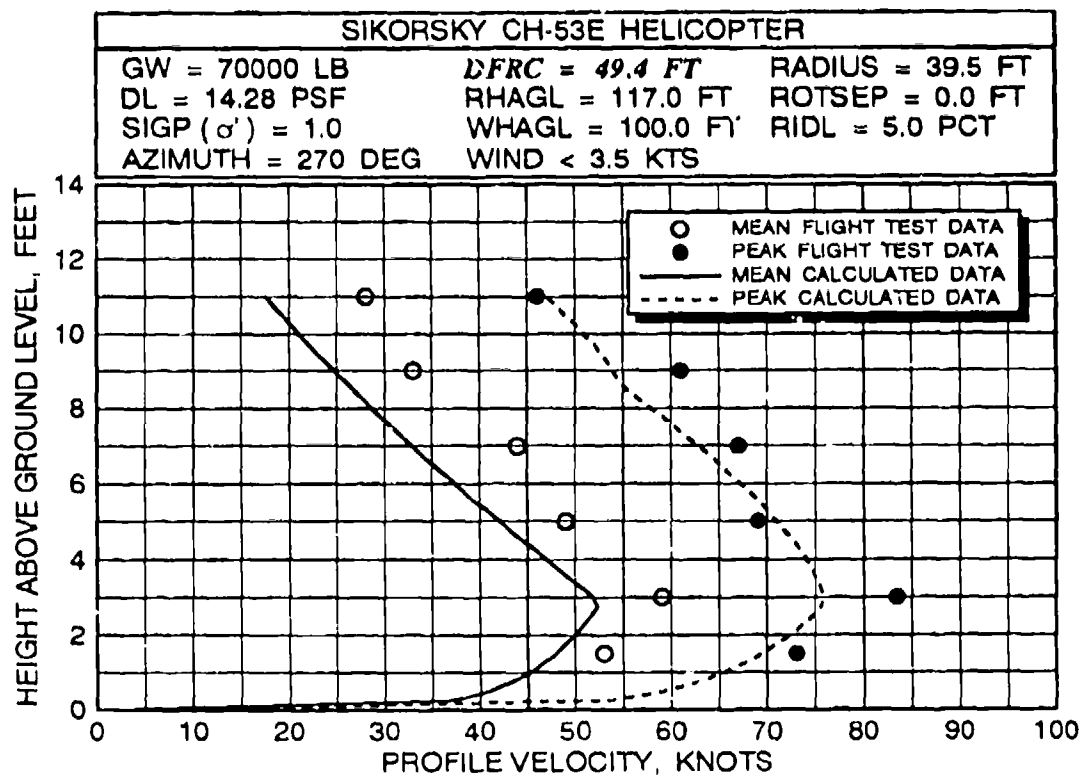


FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

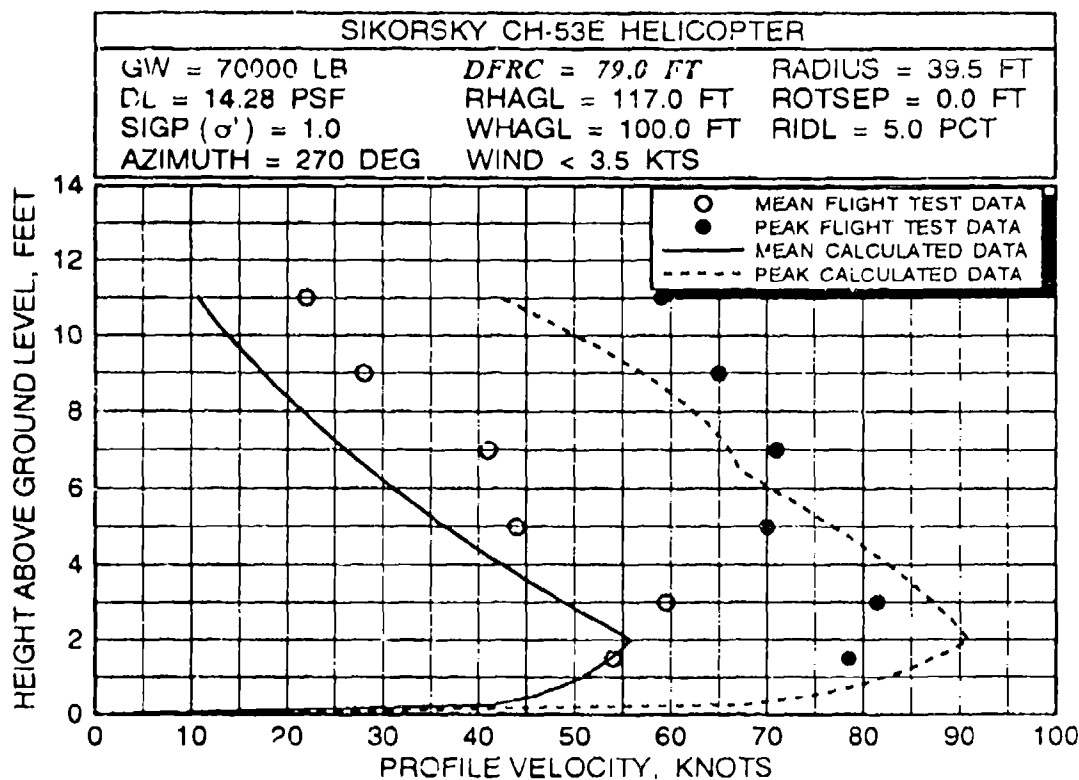
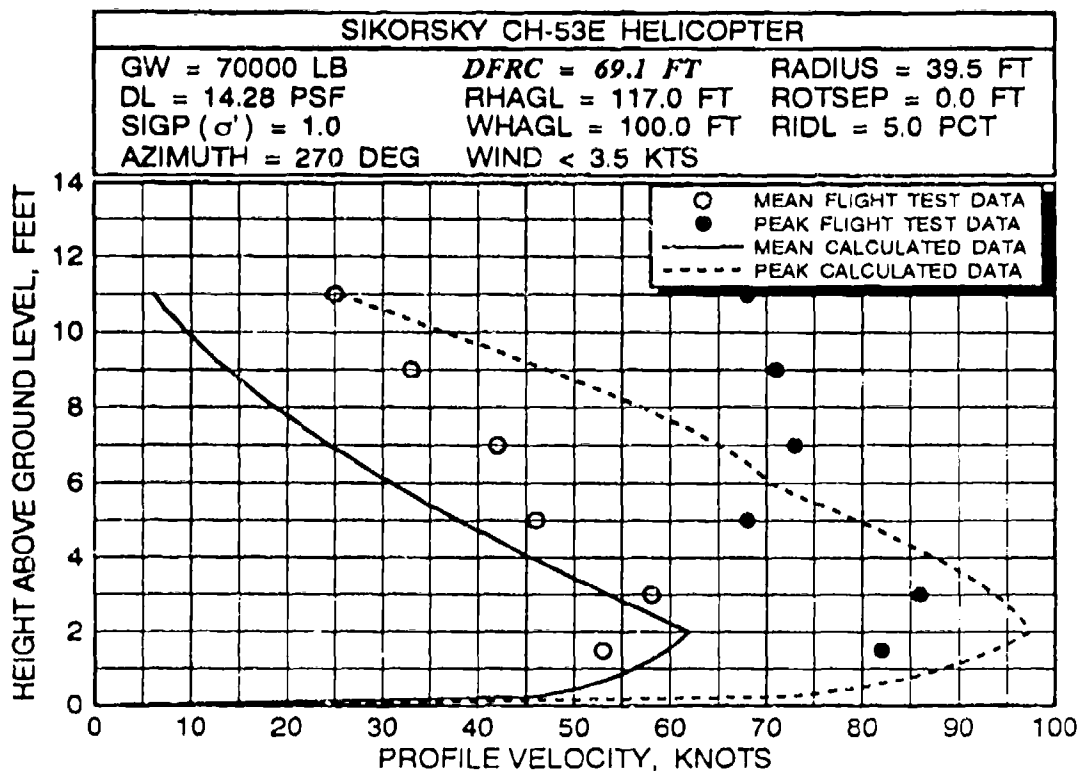


FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

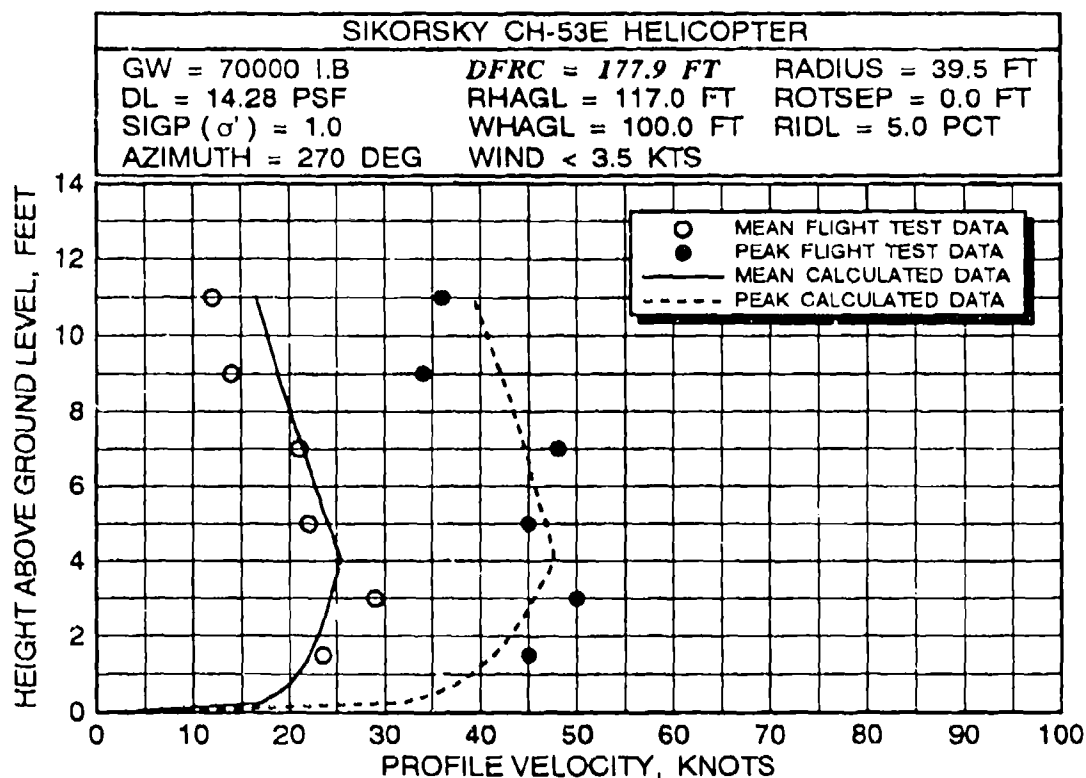
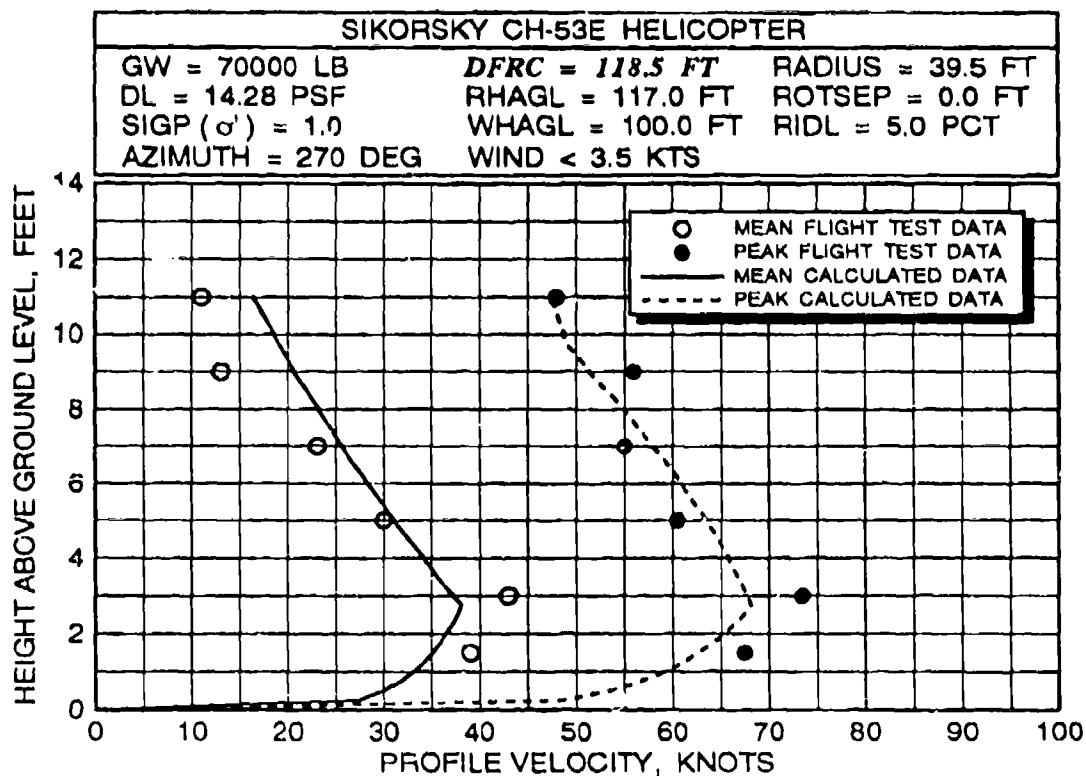


FIGURE B-4 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 70,000 POUNDS (continued)

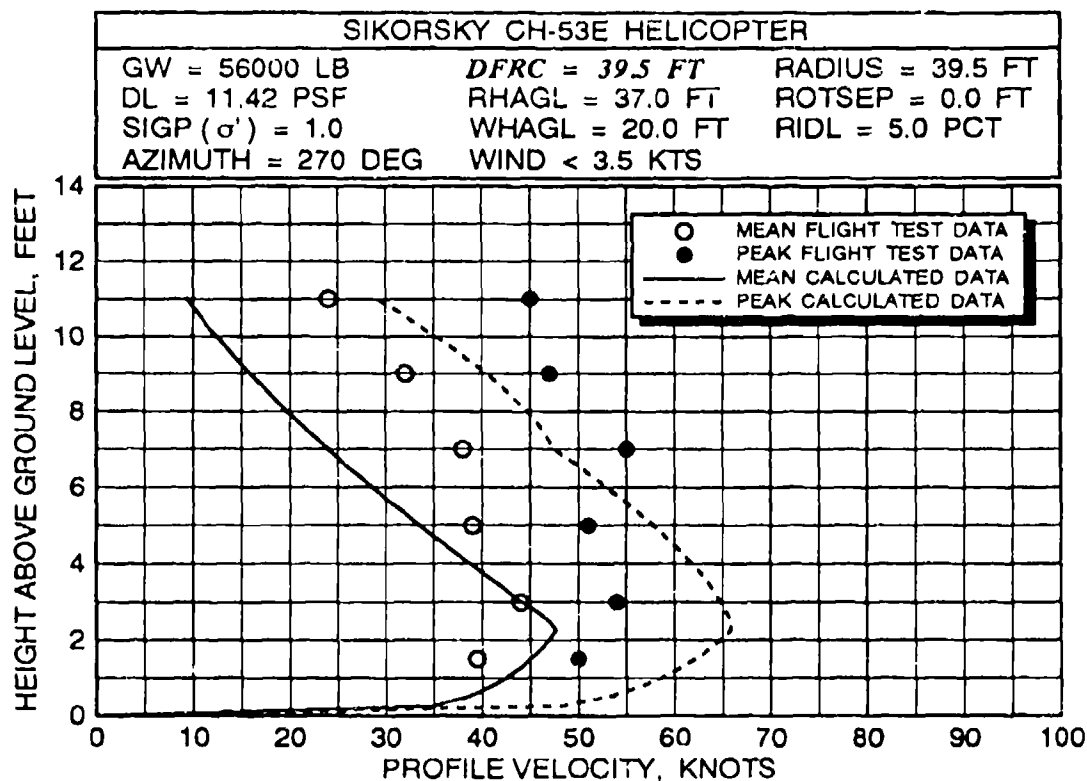
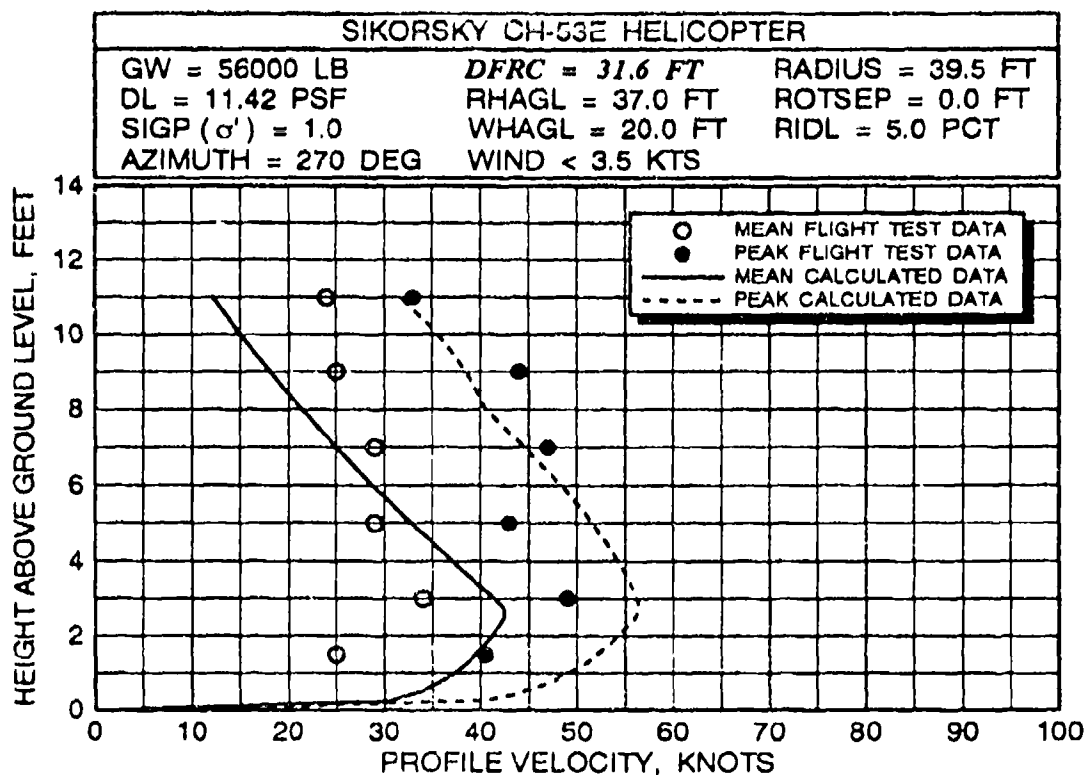


FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS

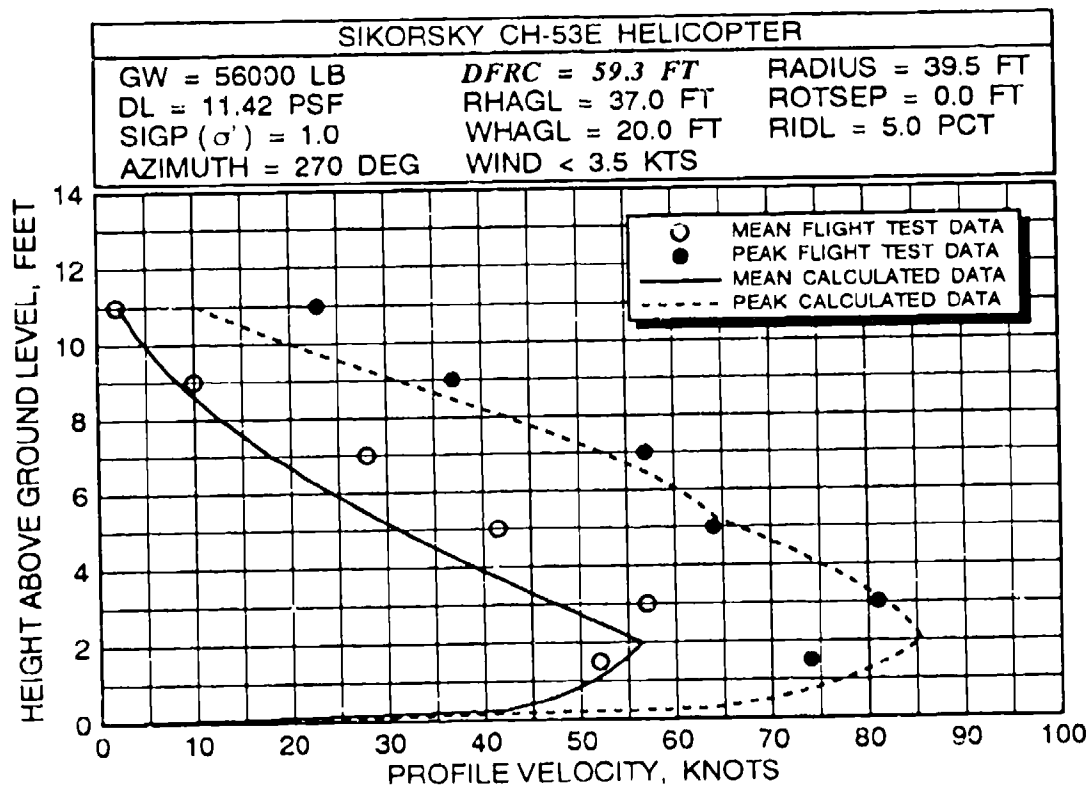
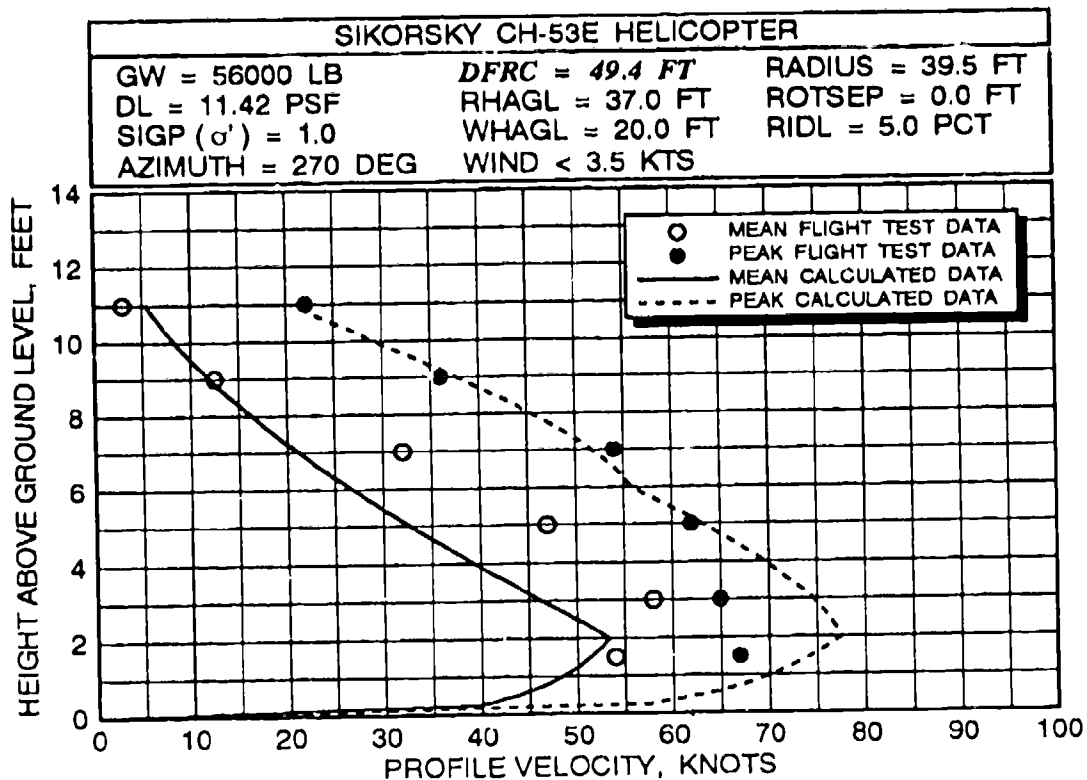


FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

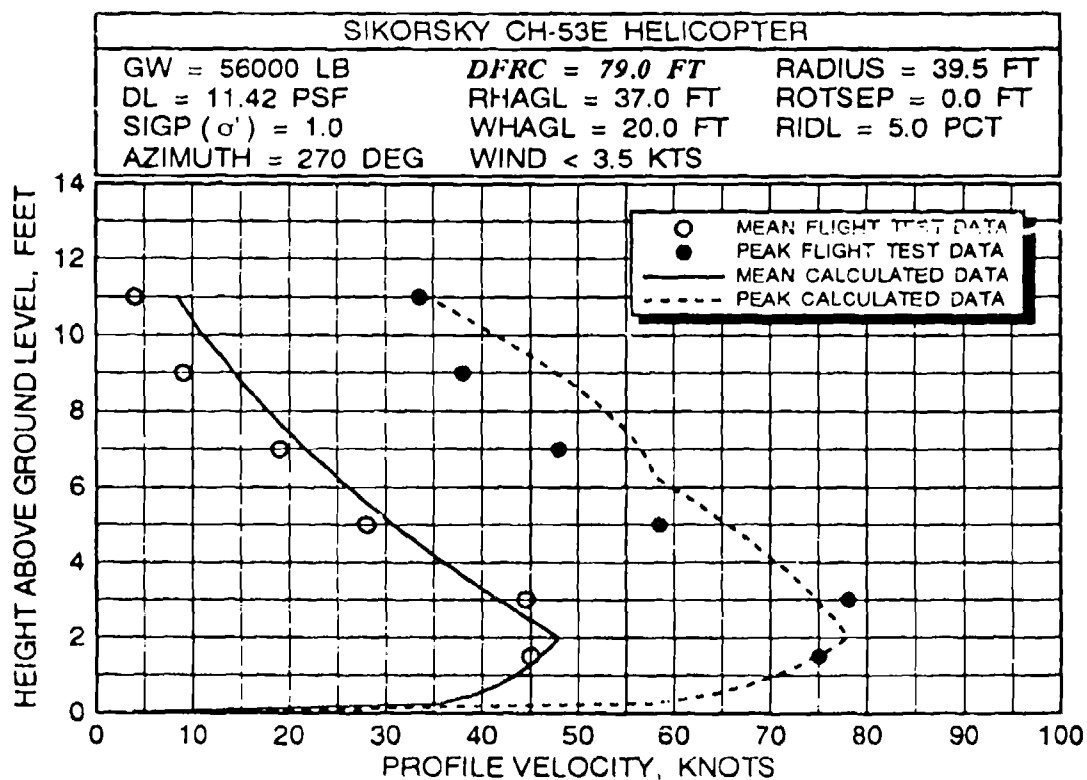
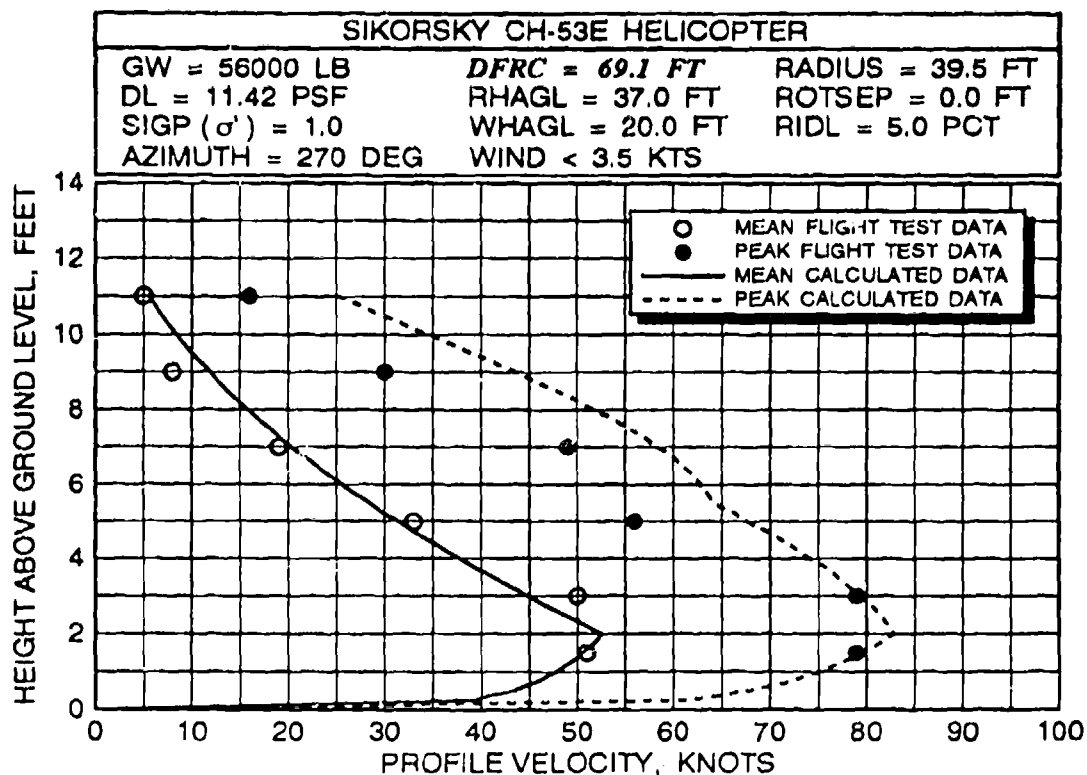


FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

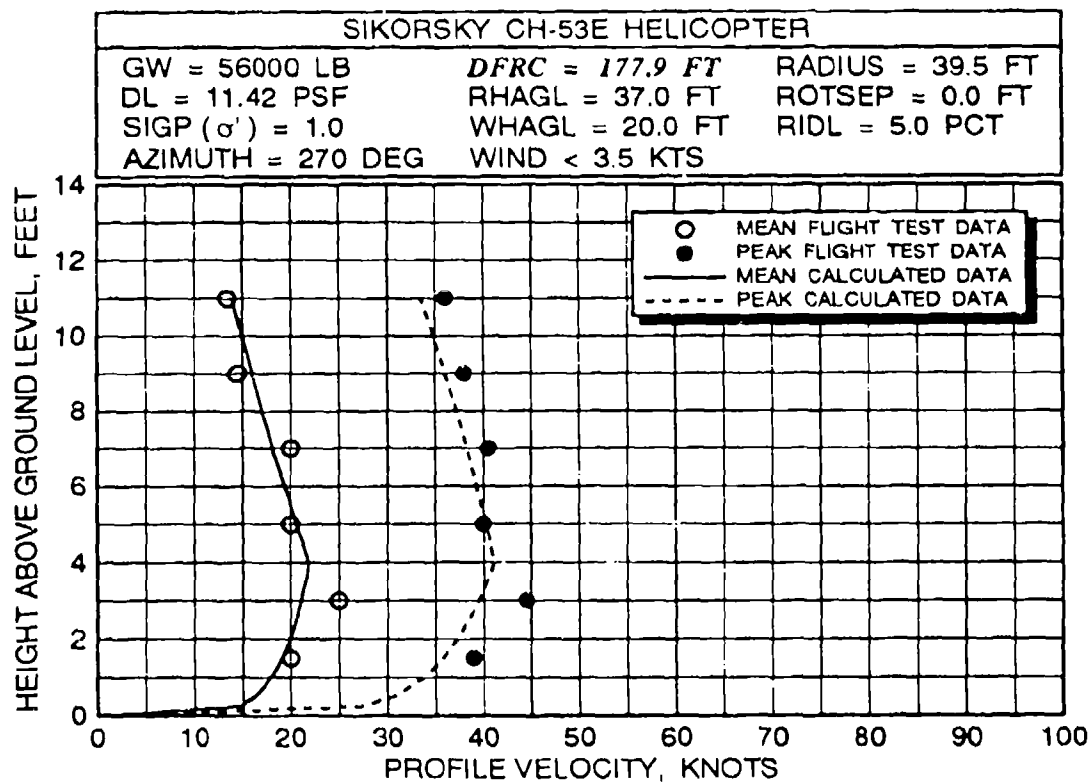
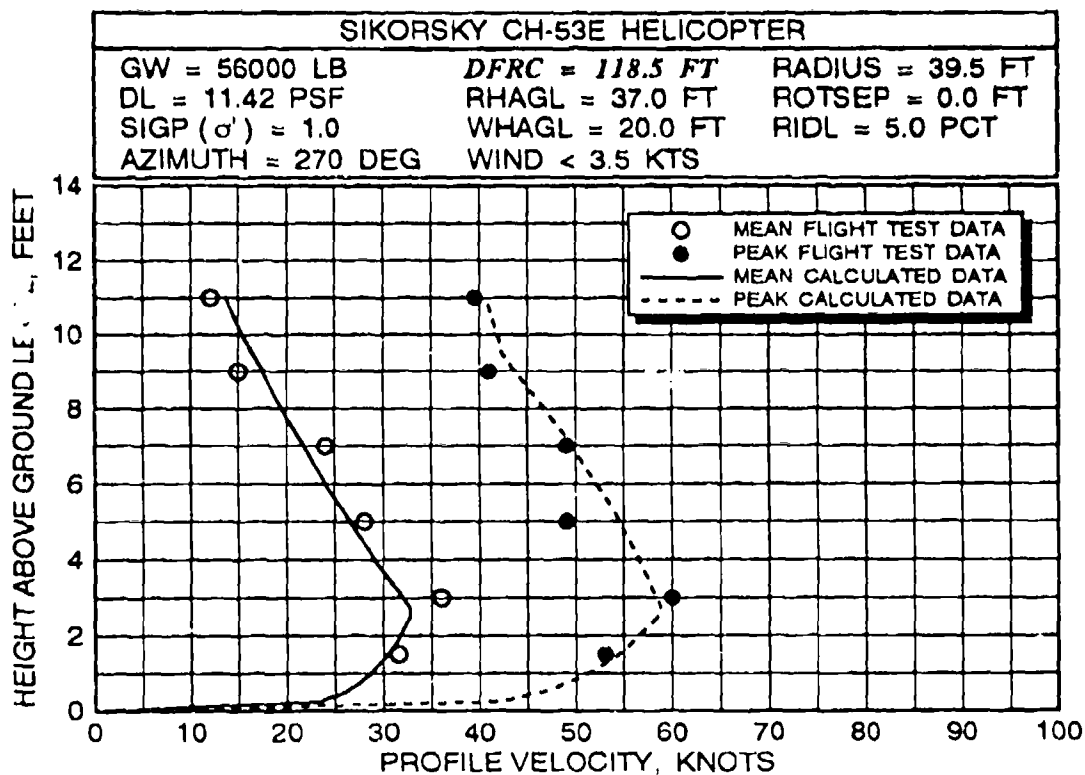


FIGURE B-5 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

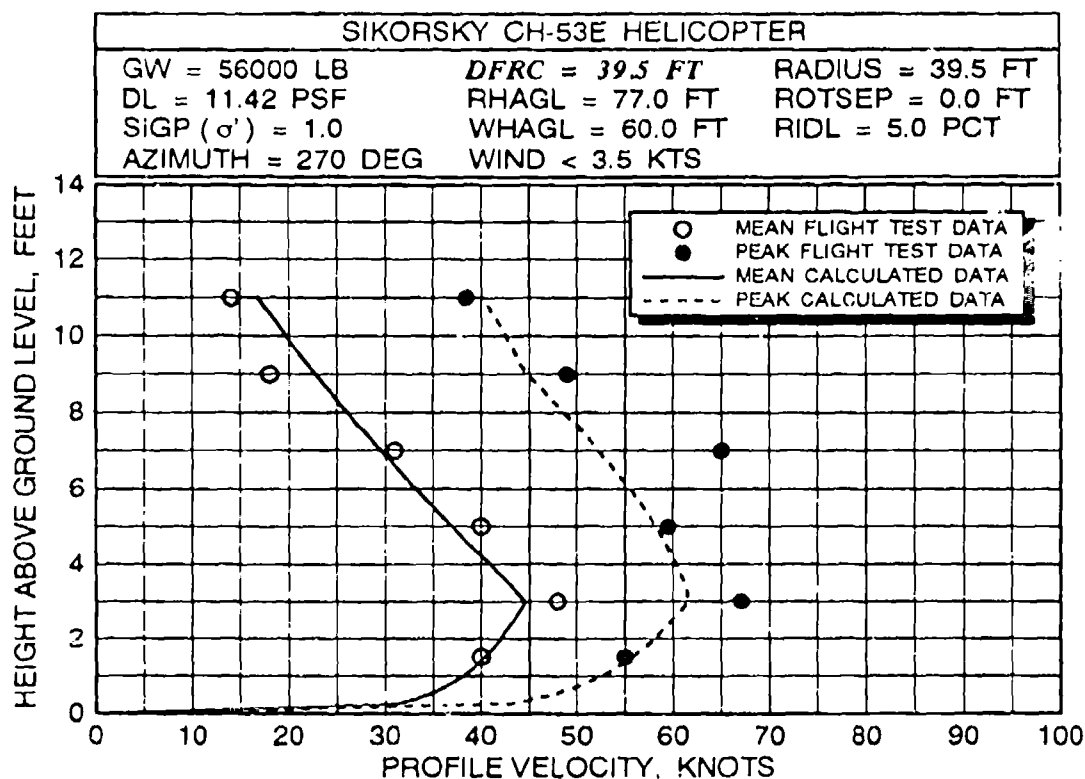
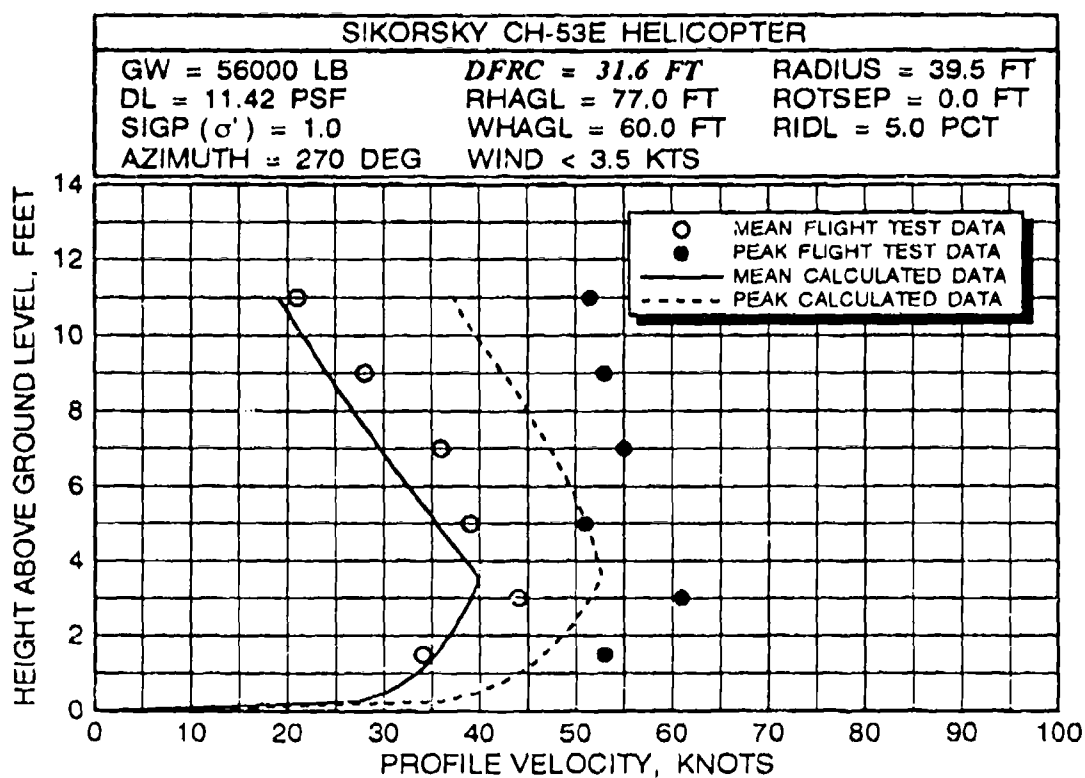


FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

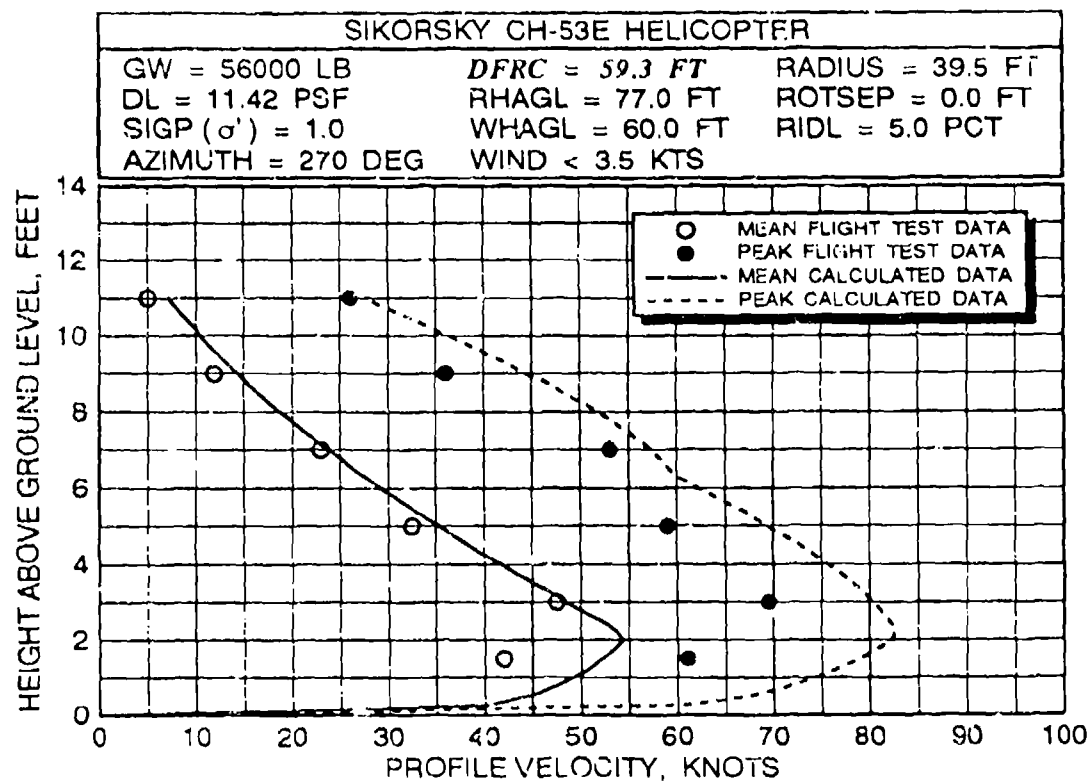
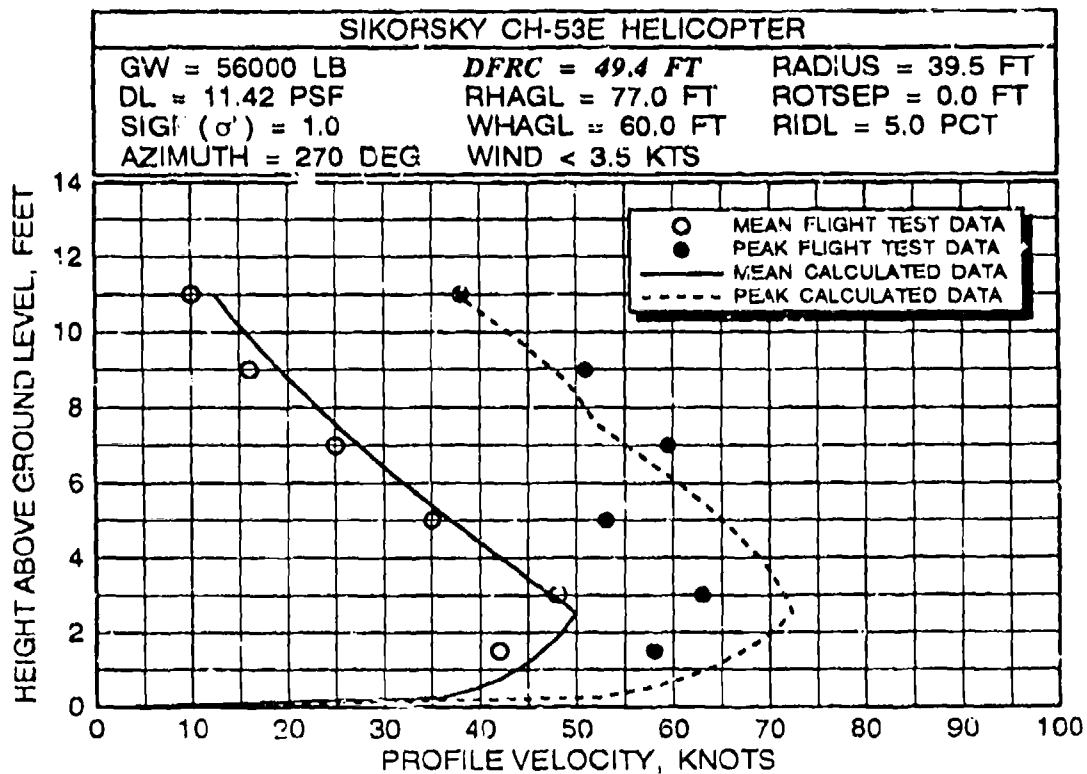


FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

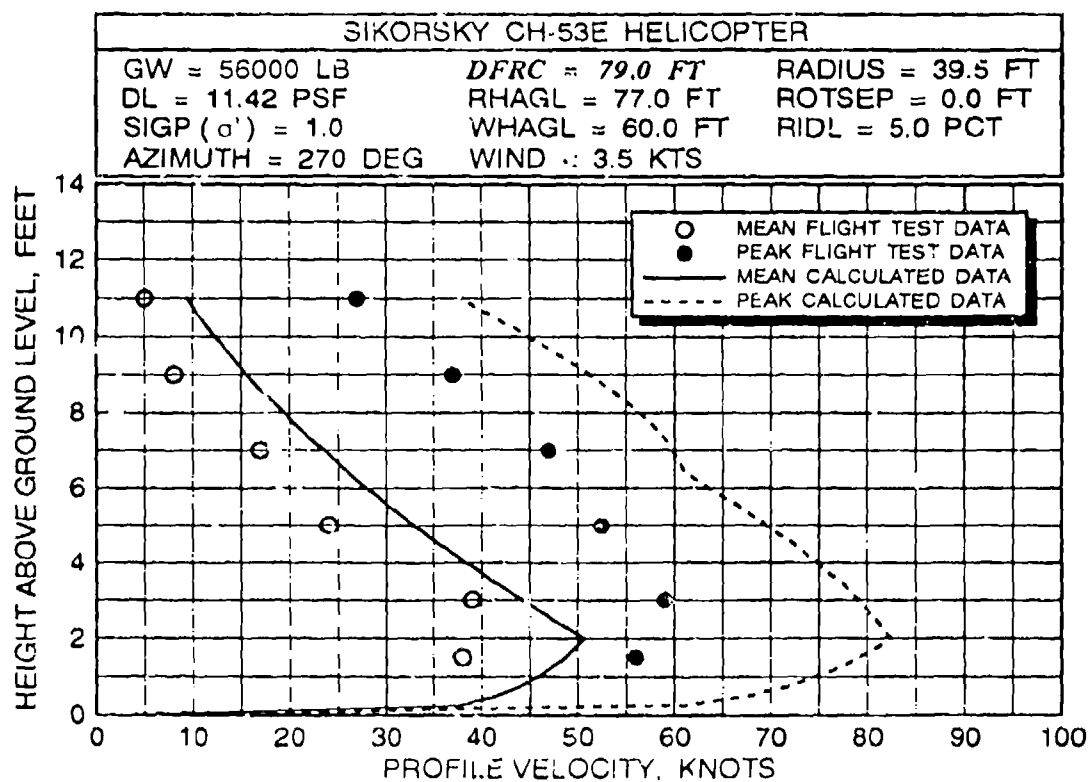
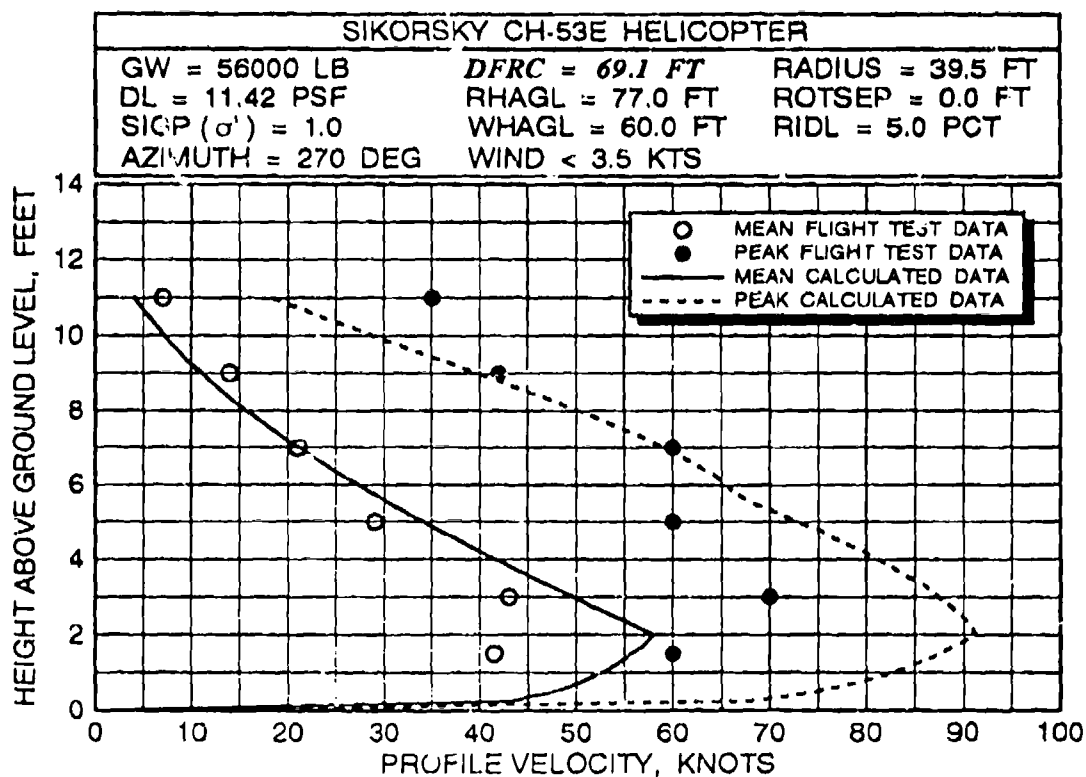


FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

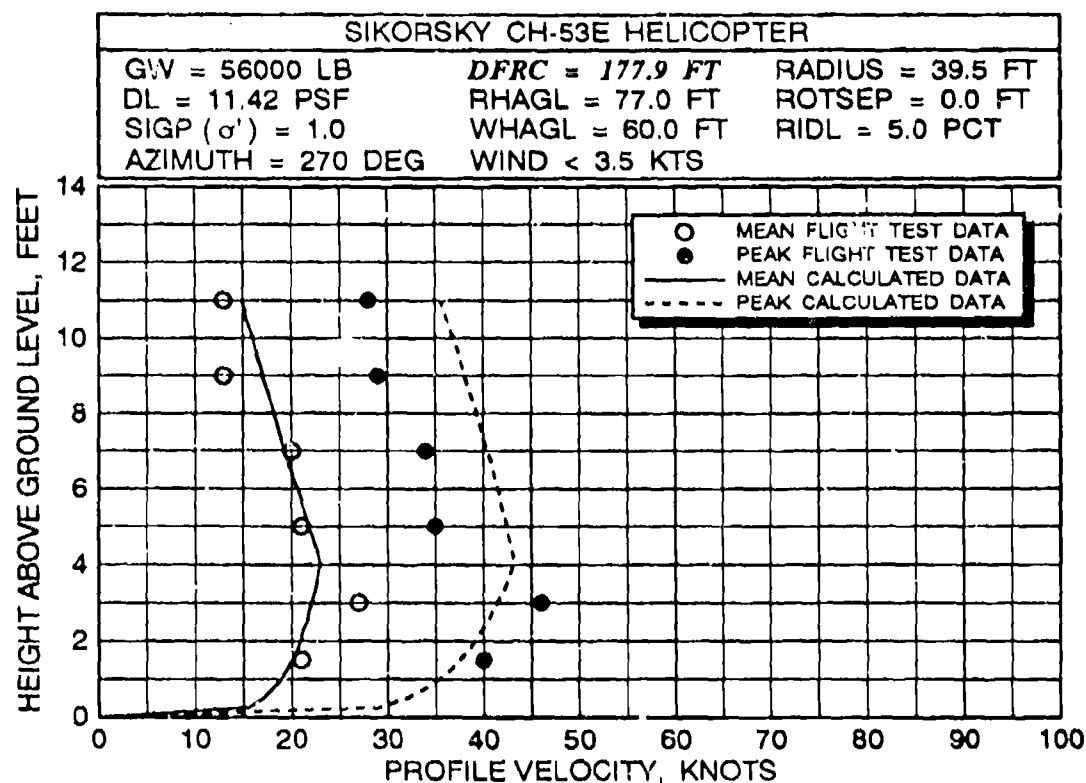
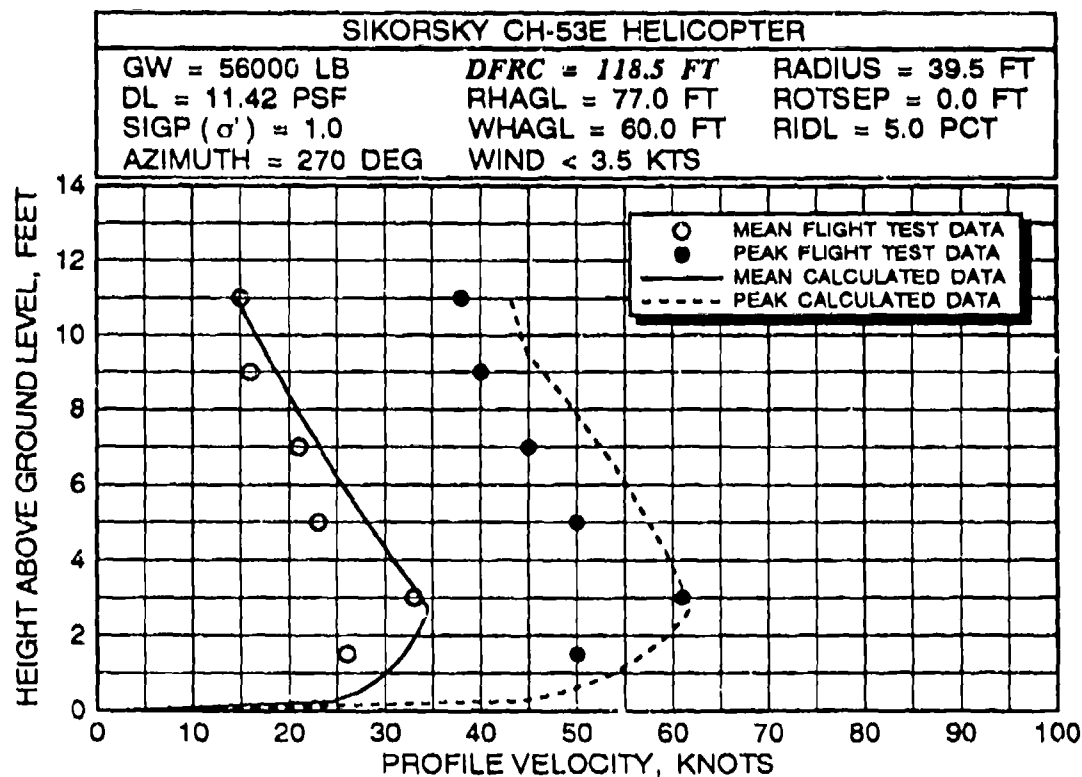


FIGURE B-6 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

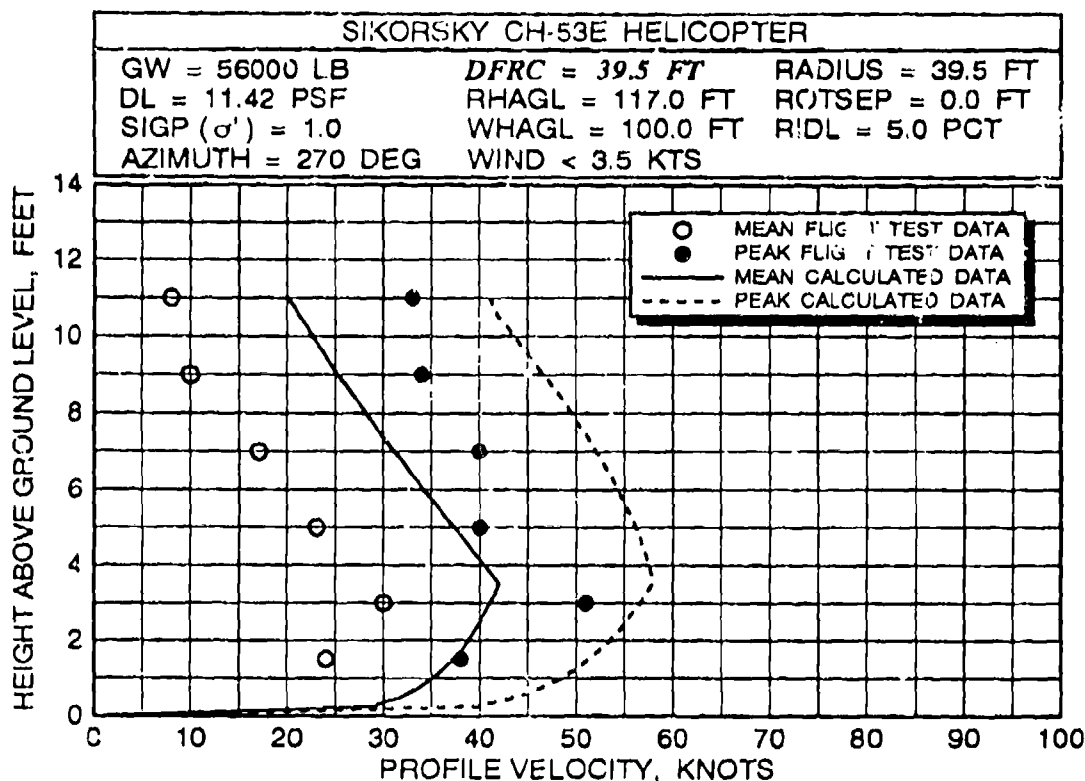
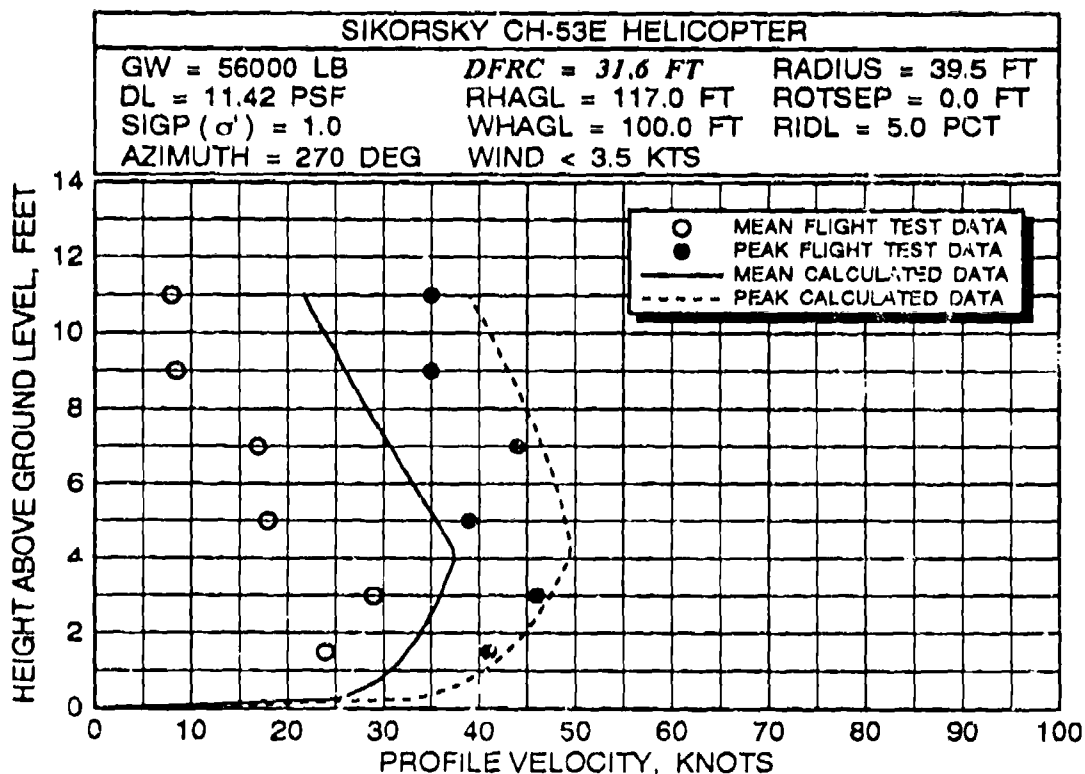


FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS

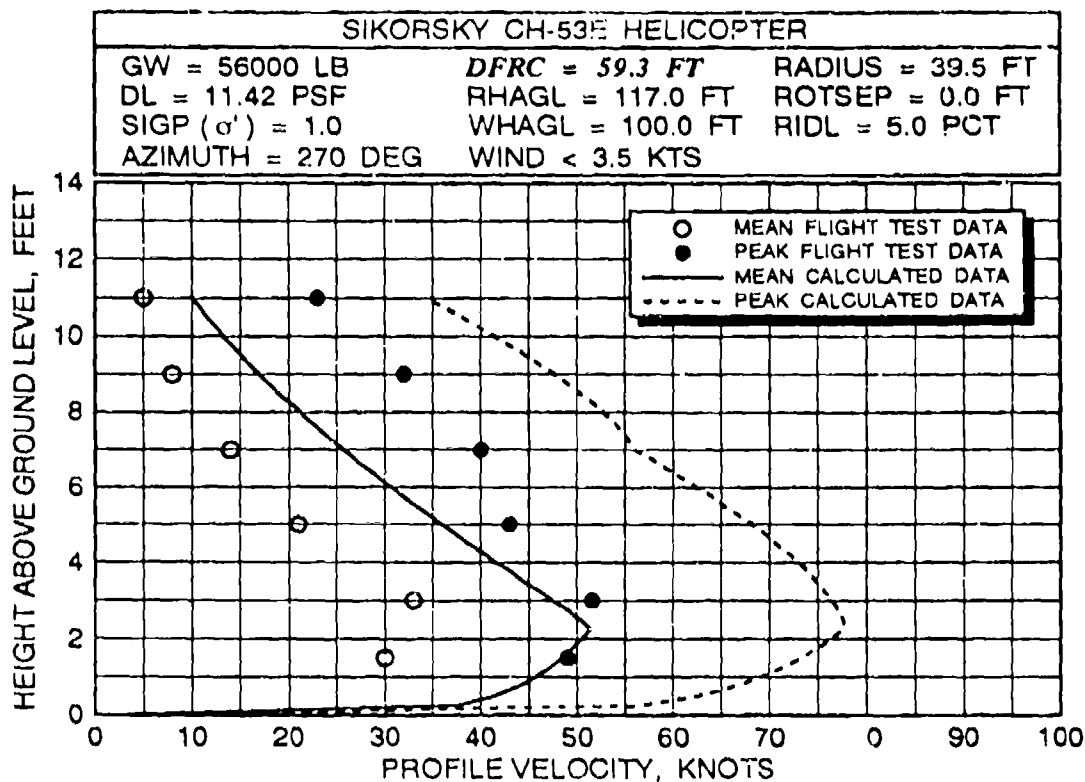
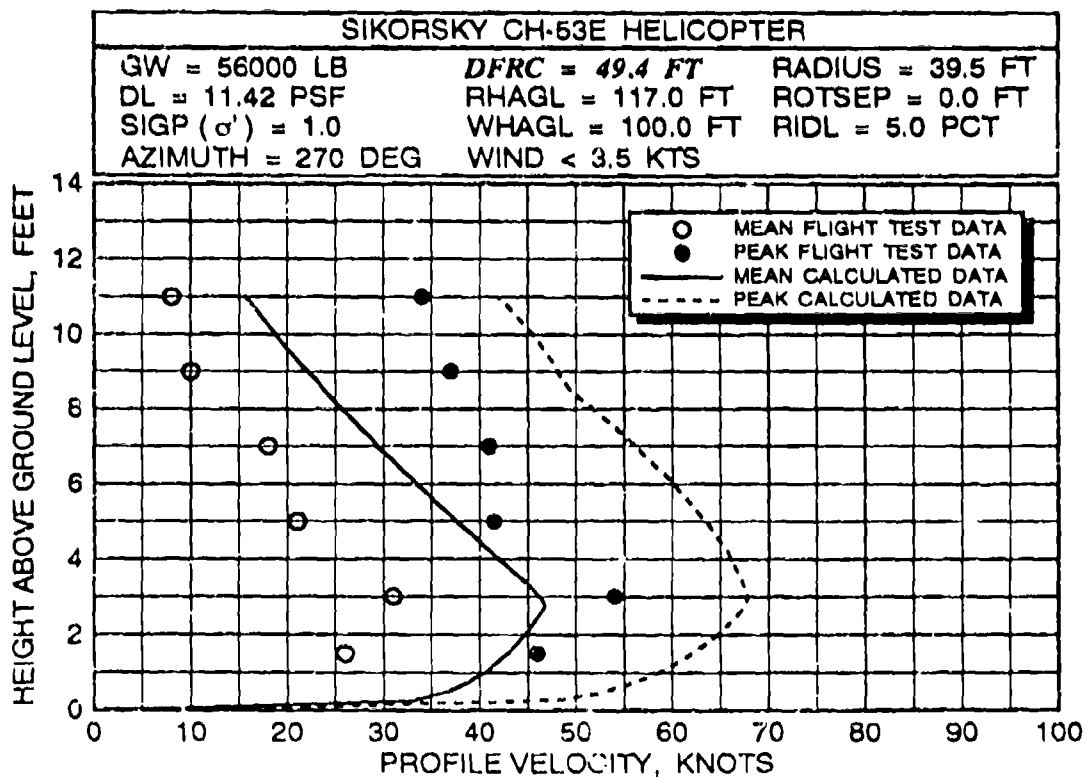


FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 56,000 POUNDS (continued)

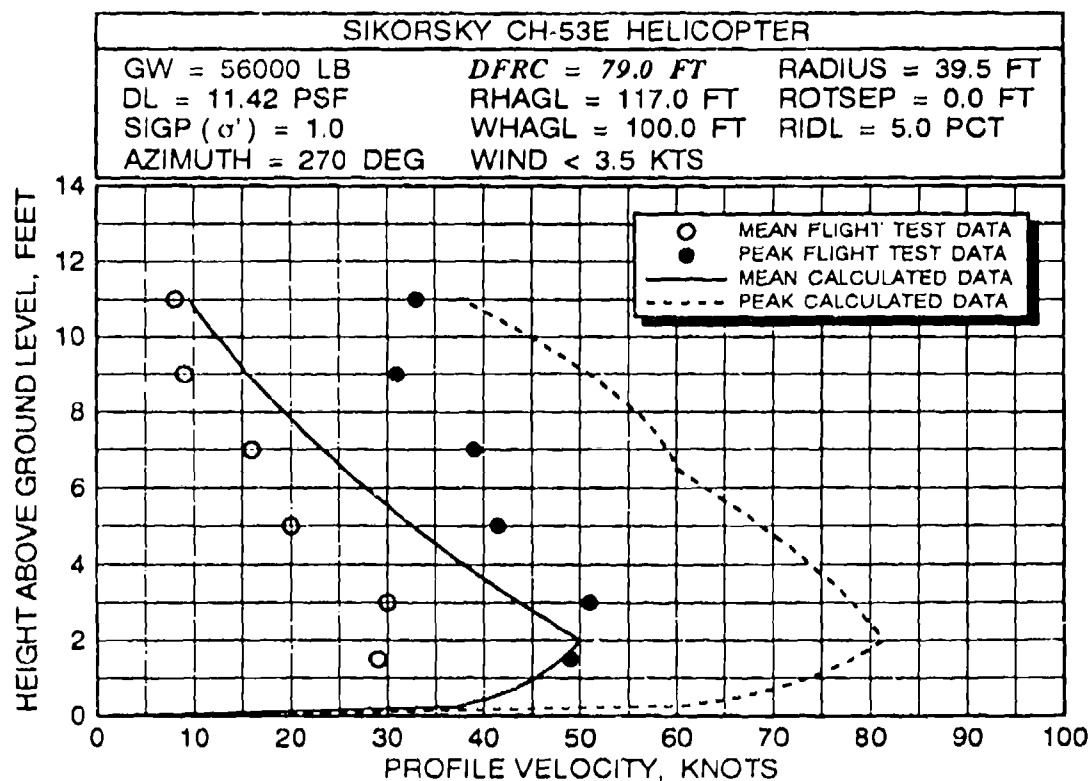
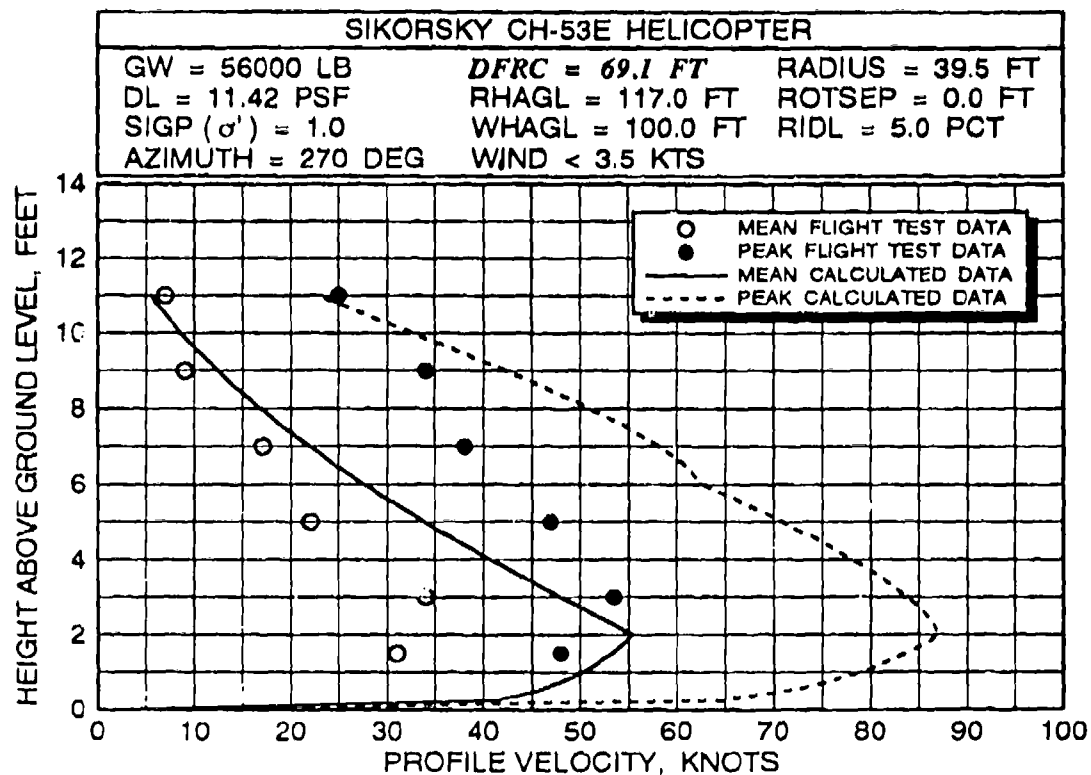


FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

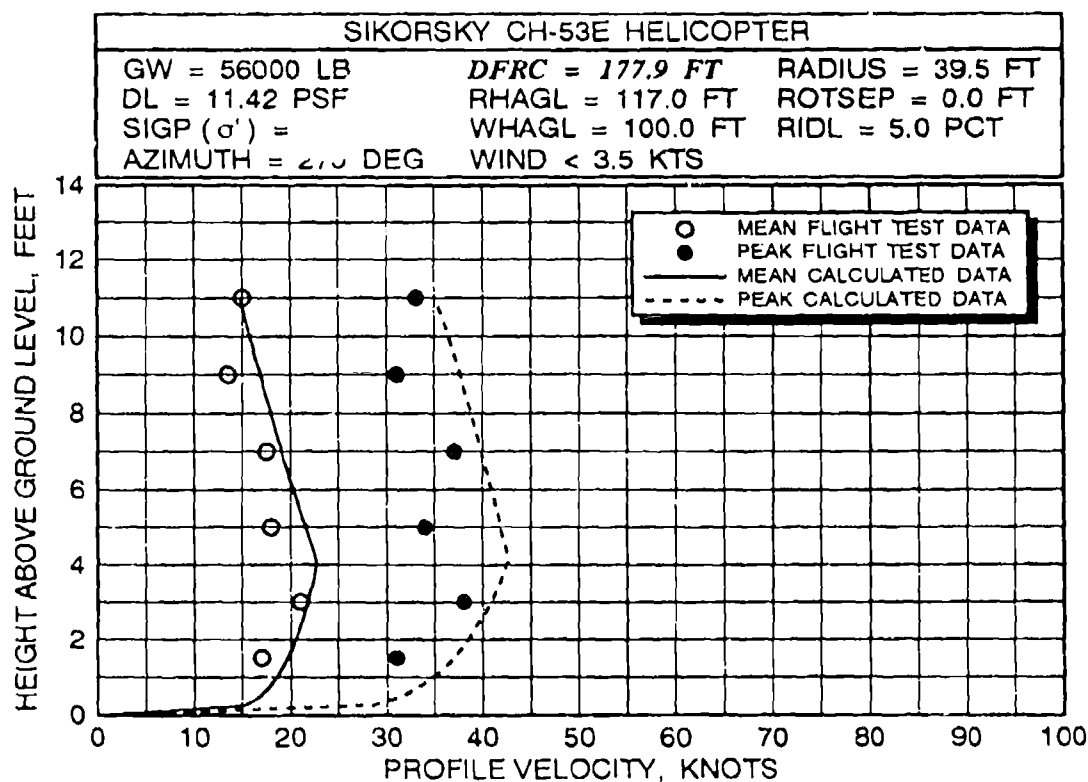
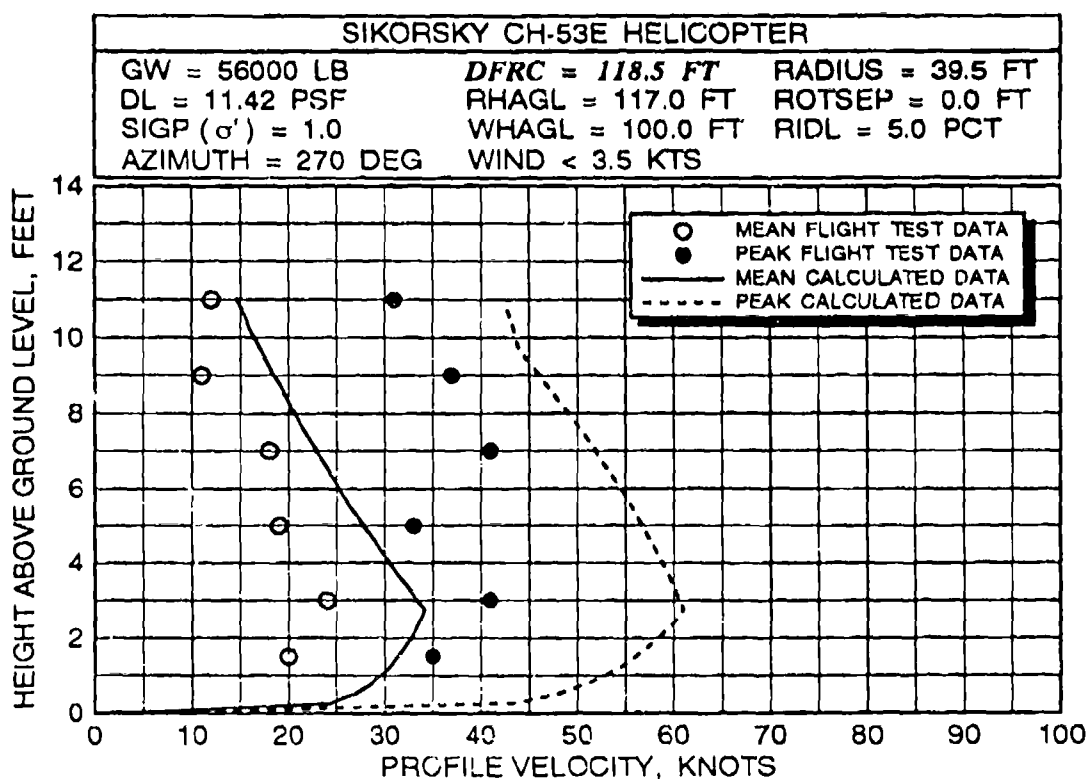


FIGURE B-7 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

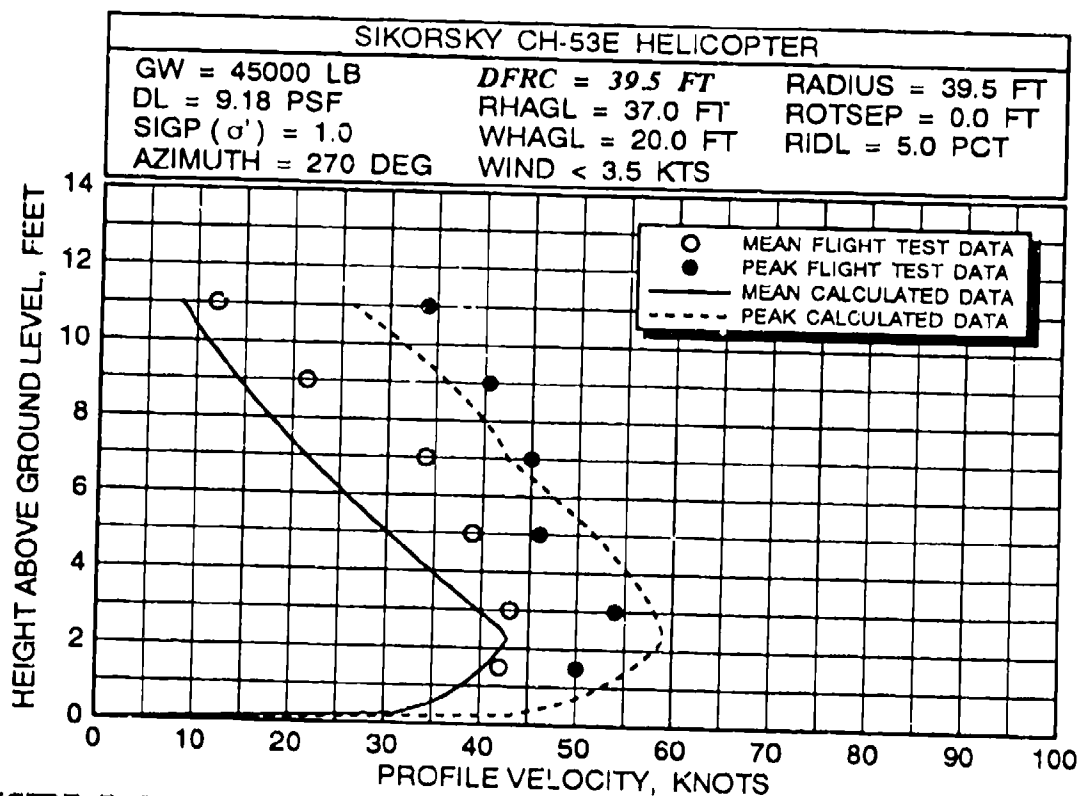
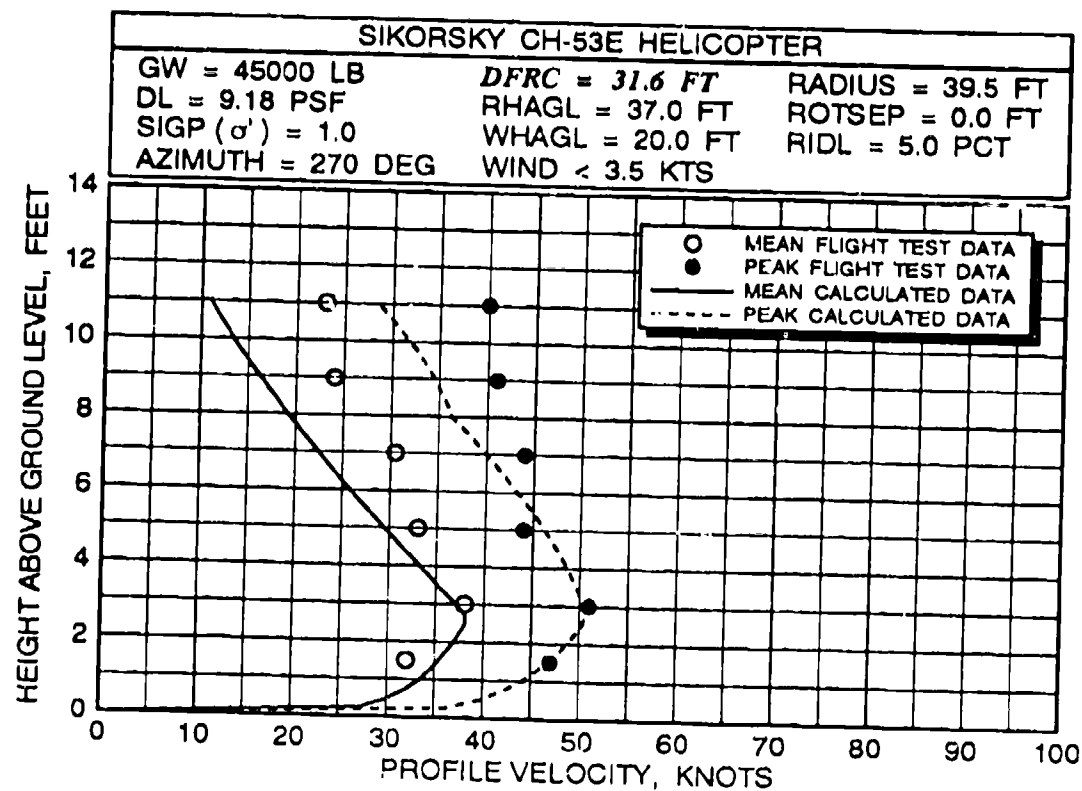


FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS

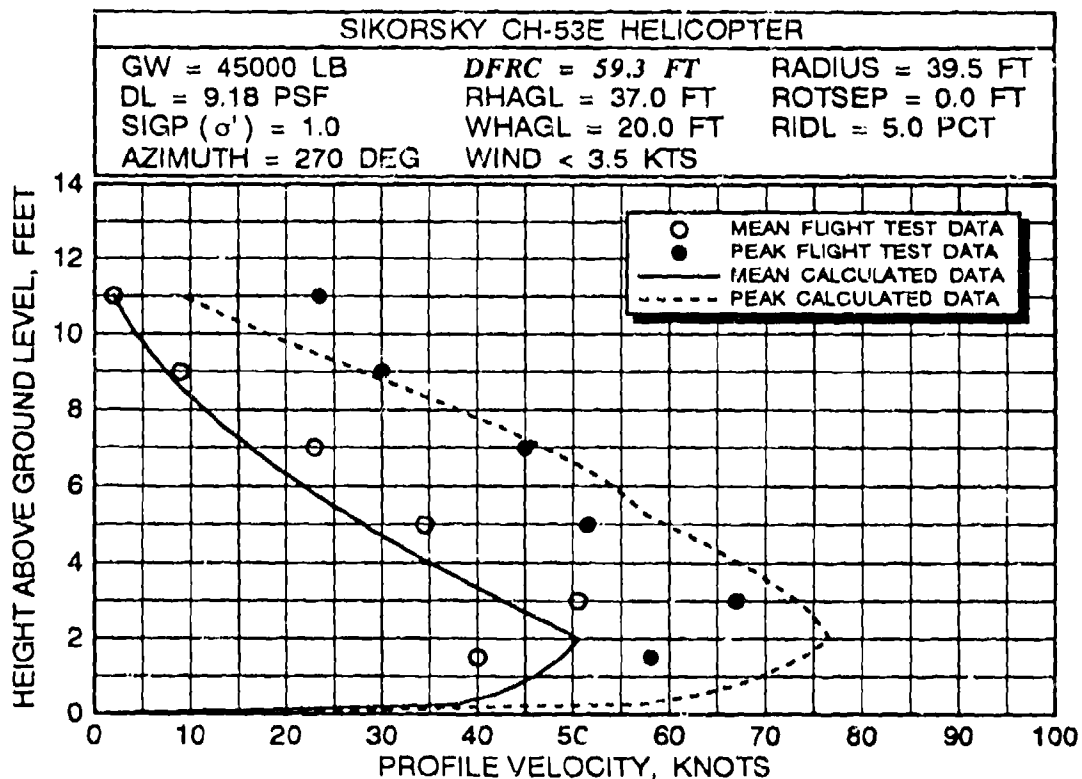
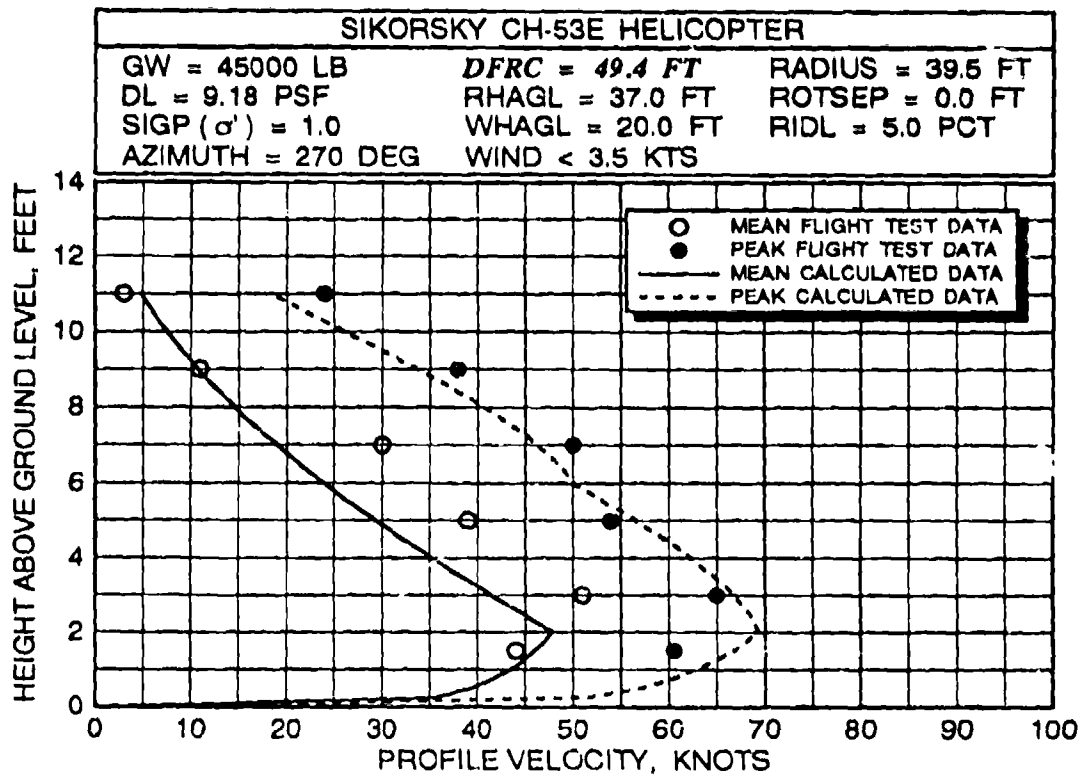


FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 37 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

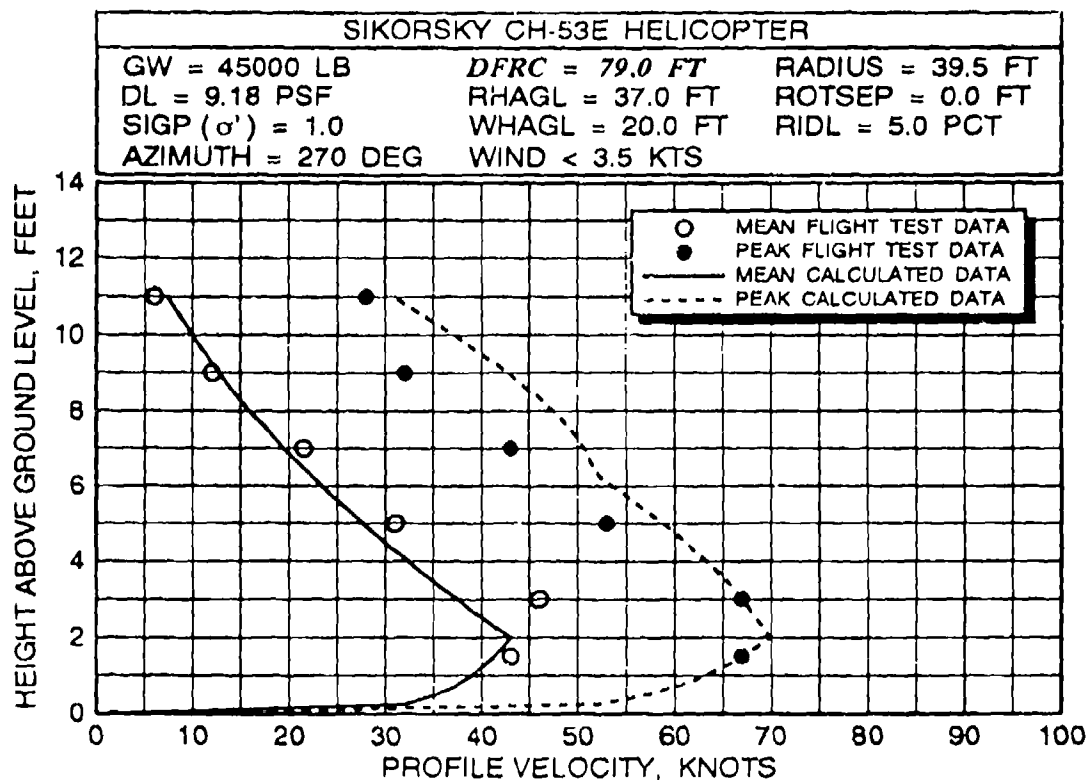
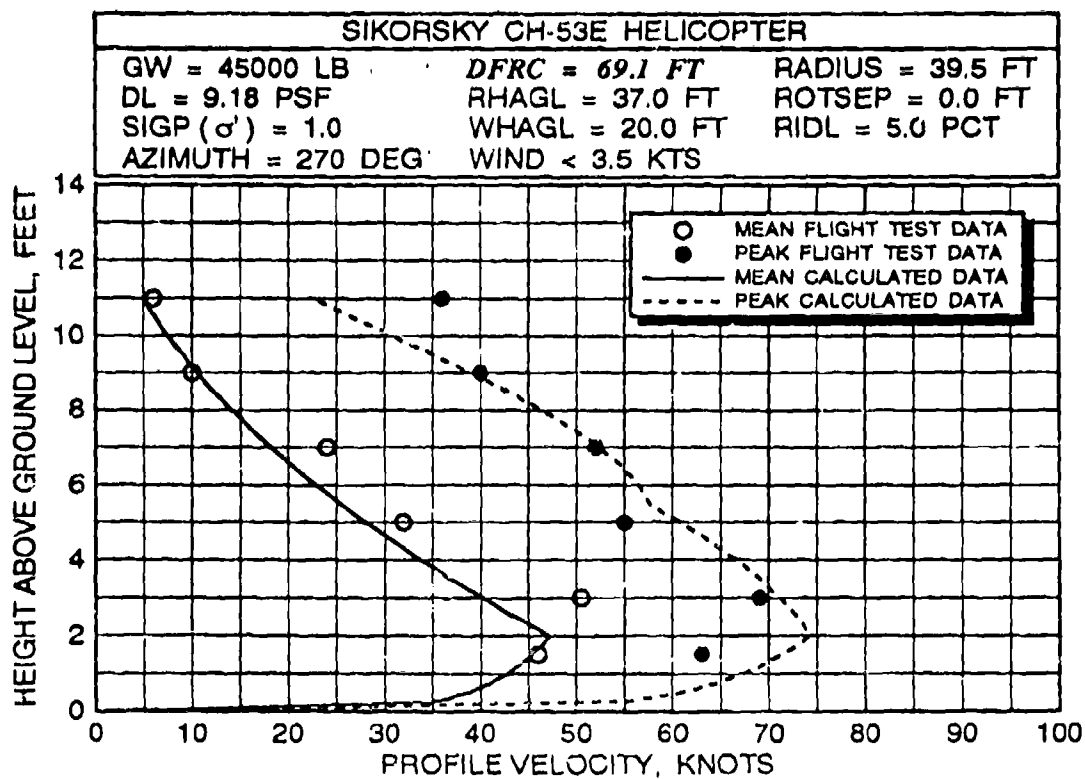


FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

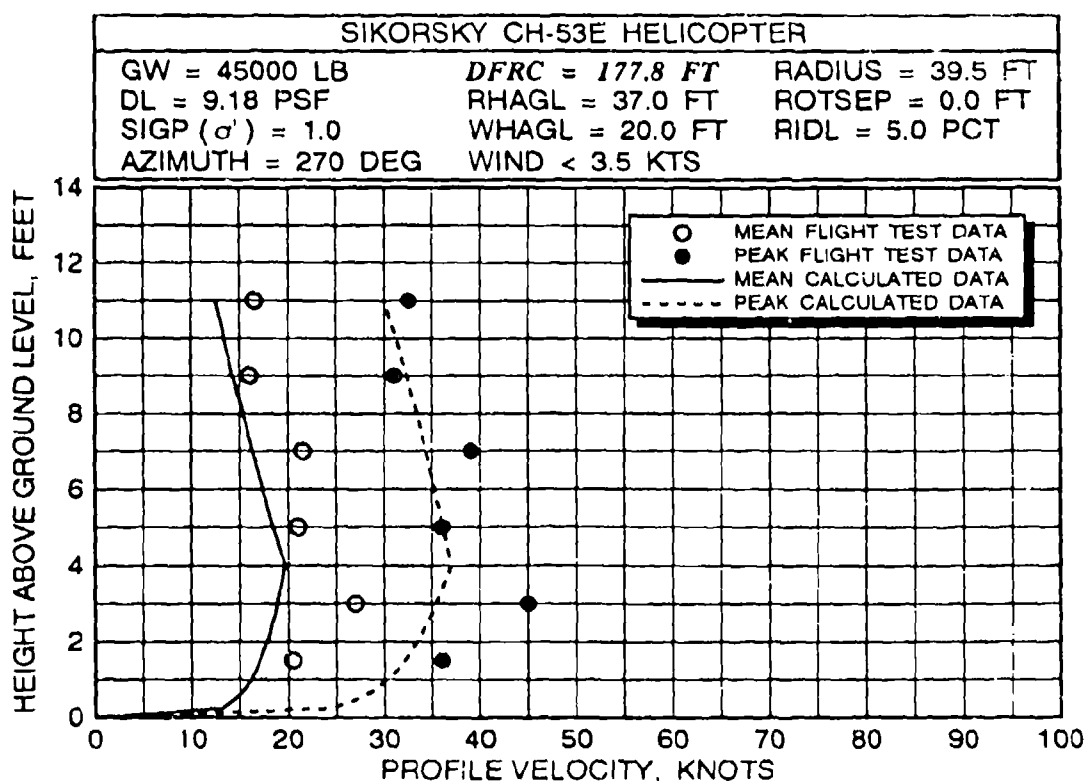
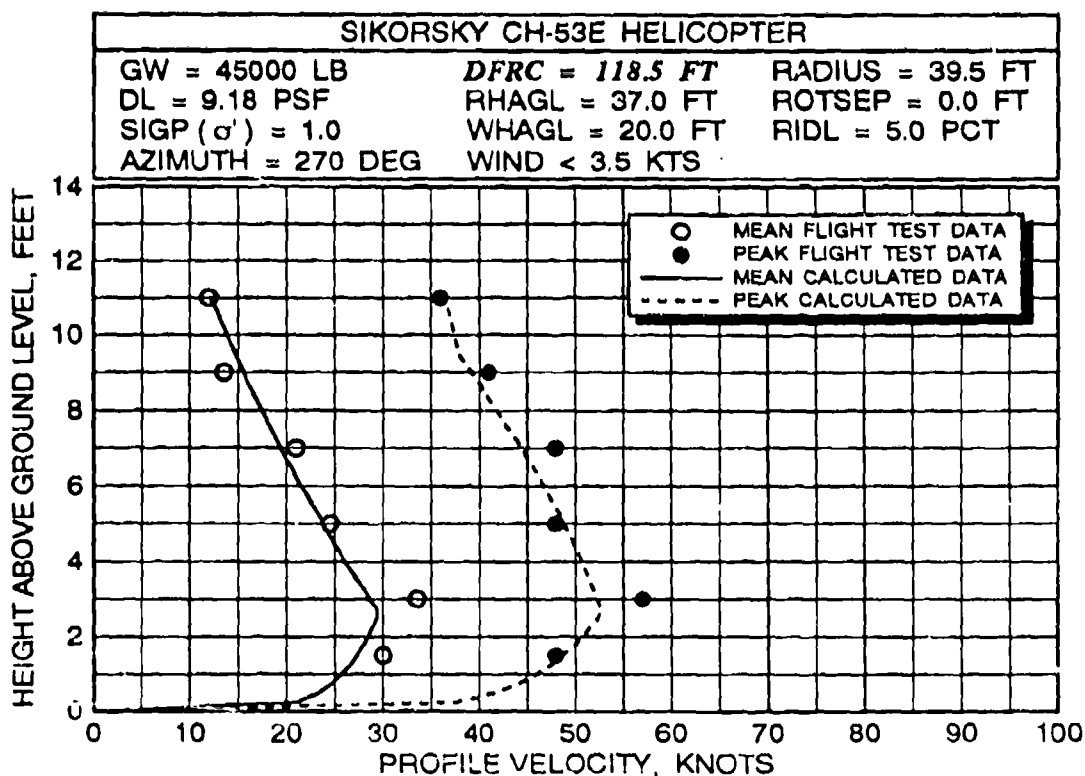


FIGURE B-8 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

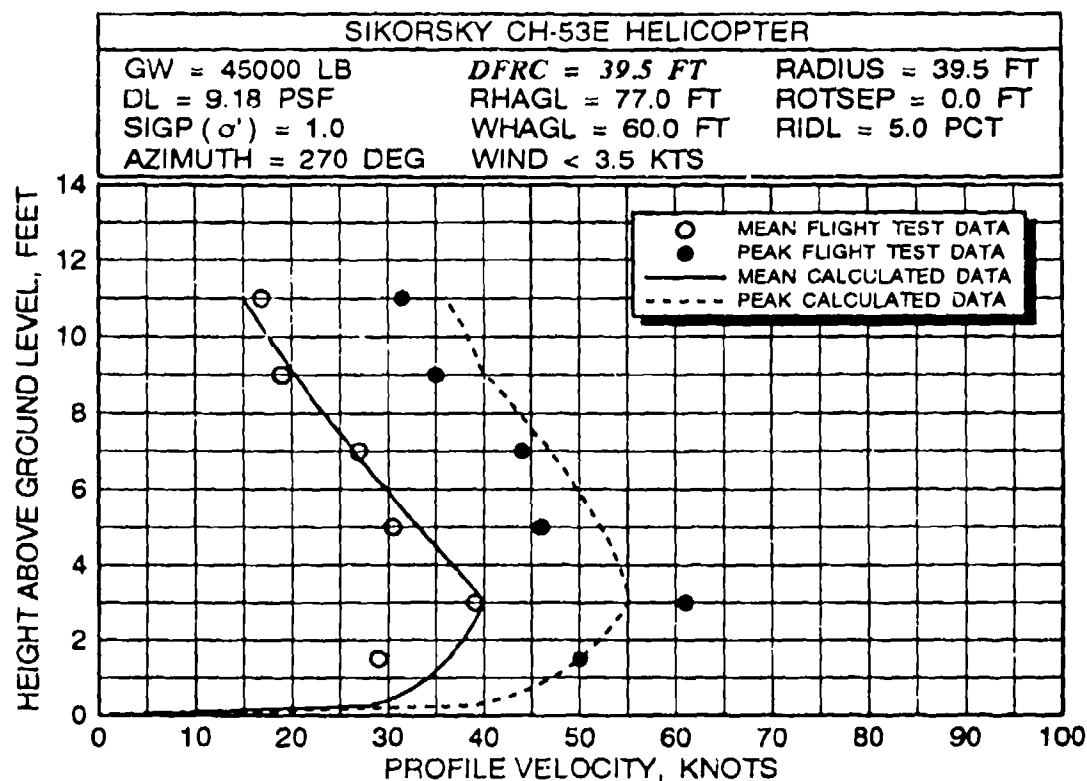
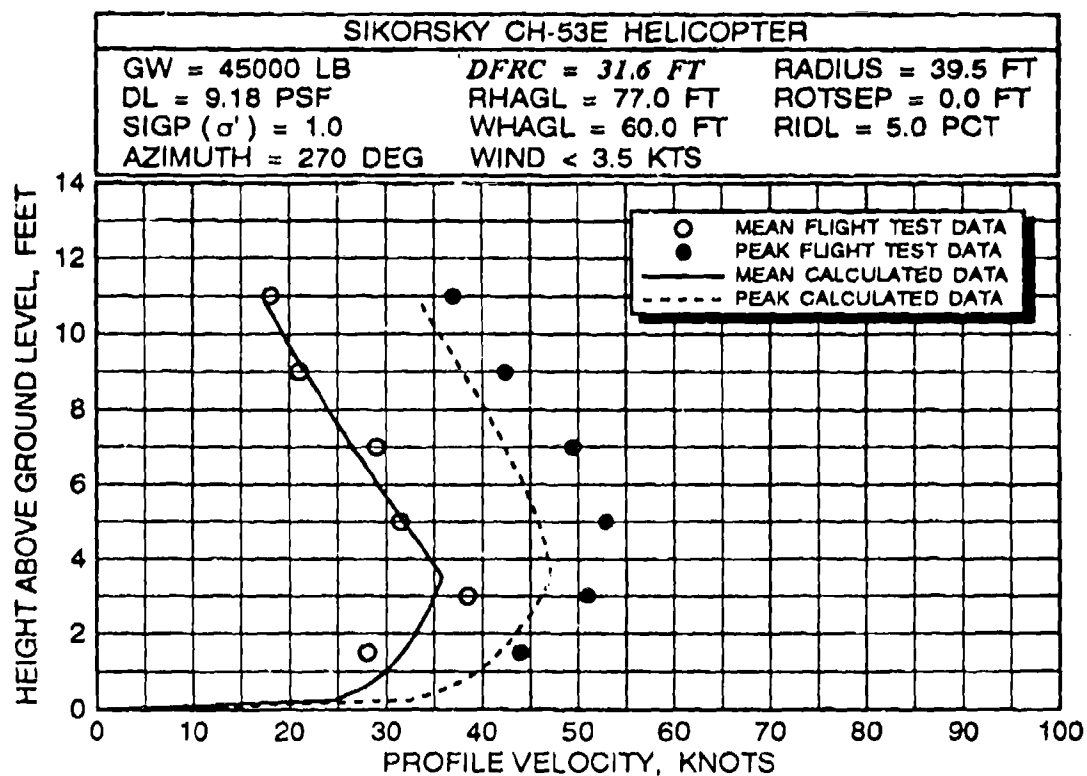


FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS

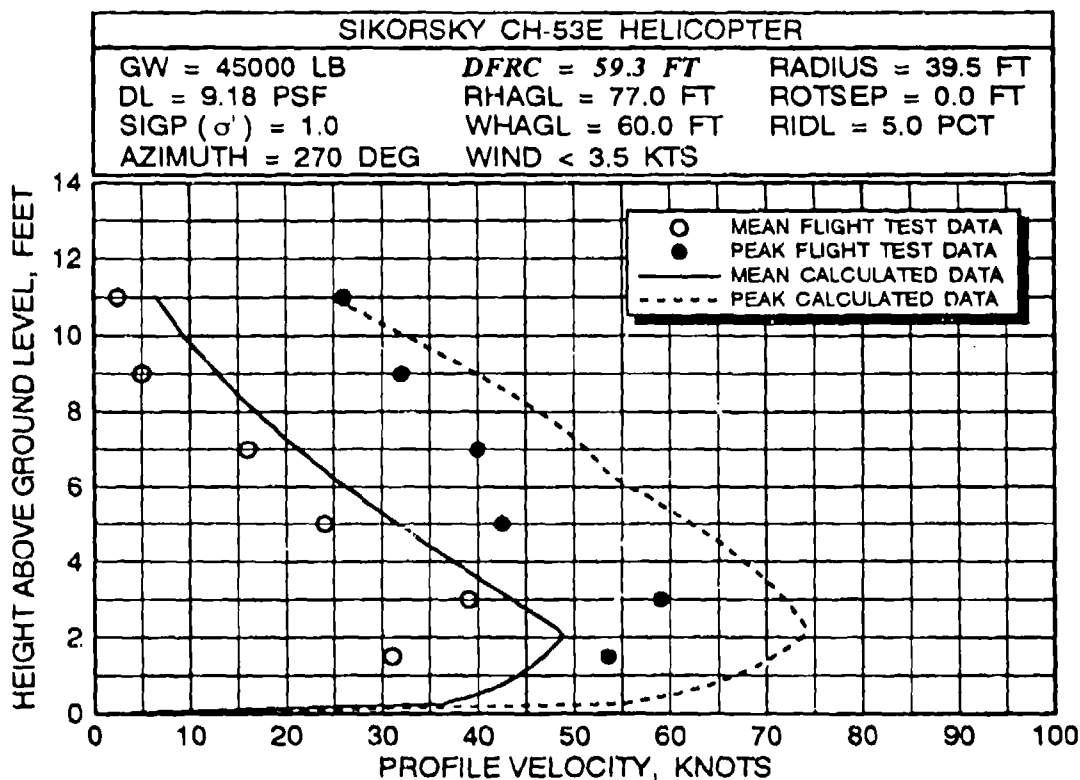
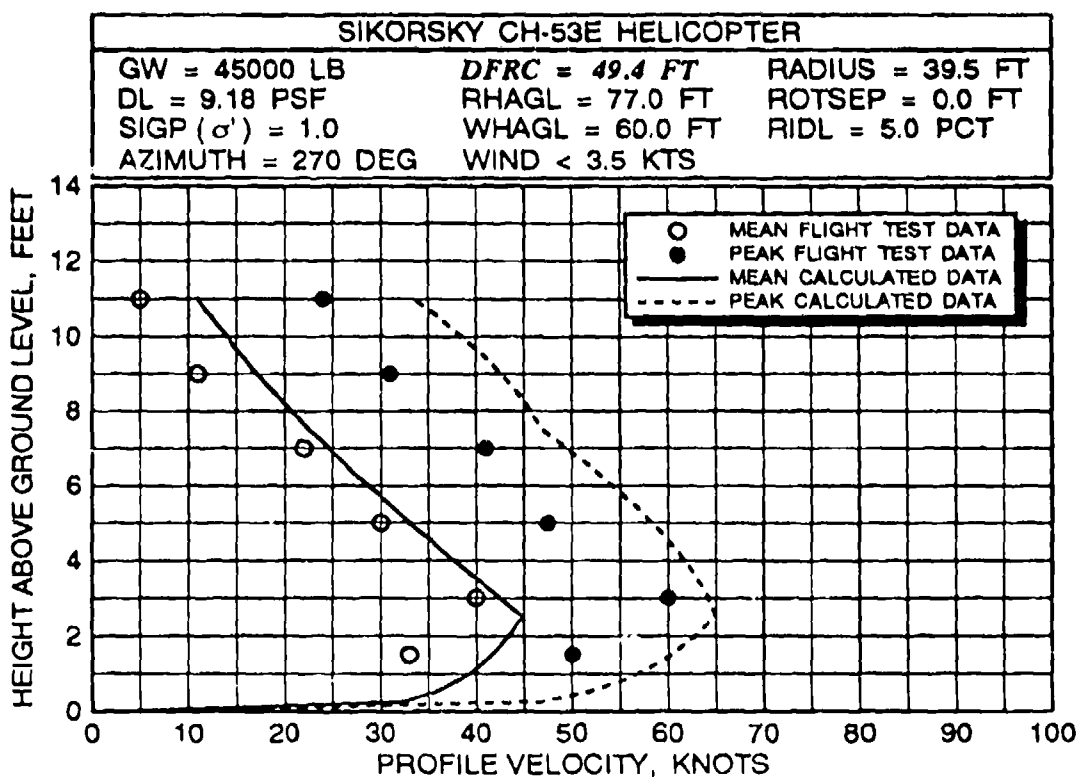


FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 77 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

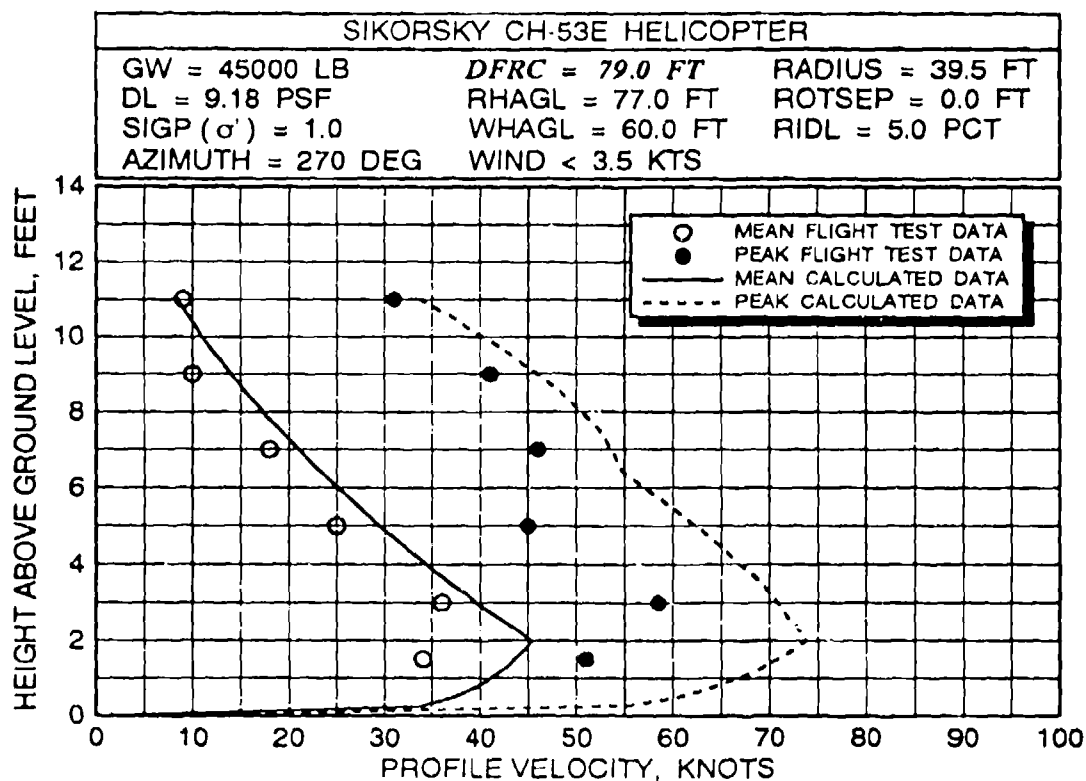
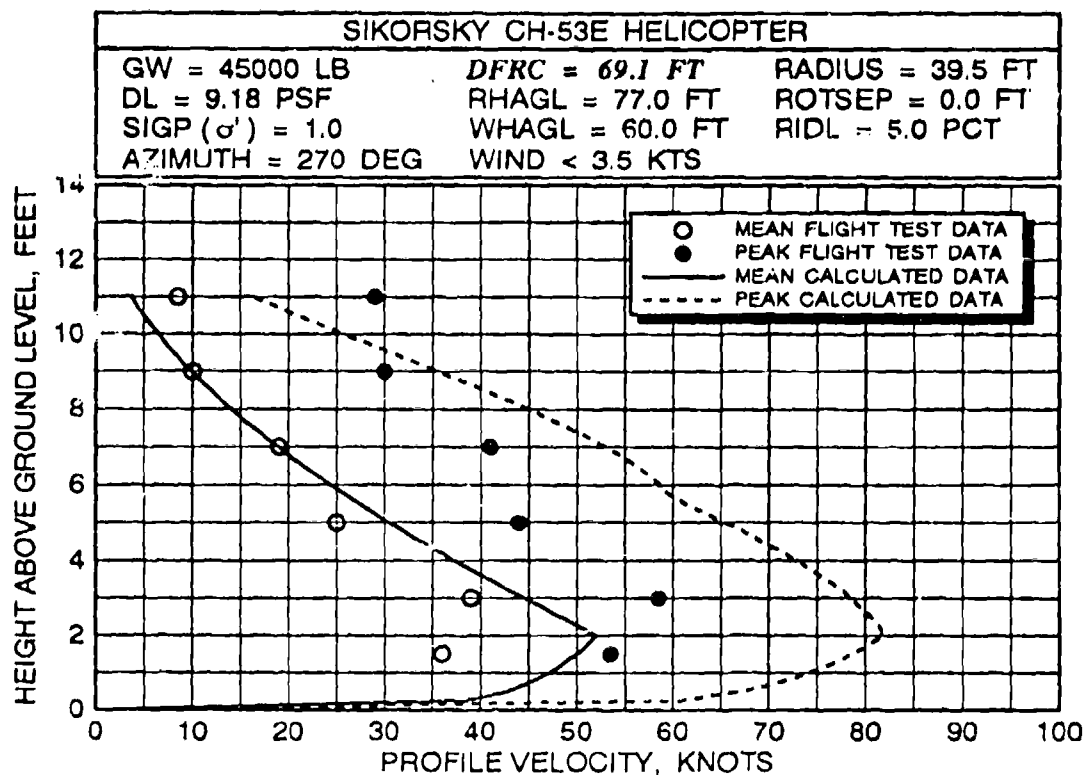


FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

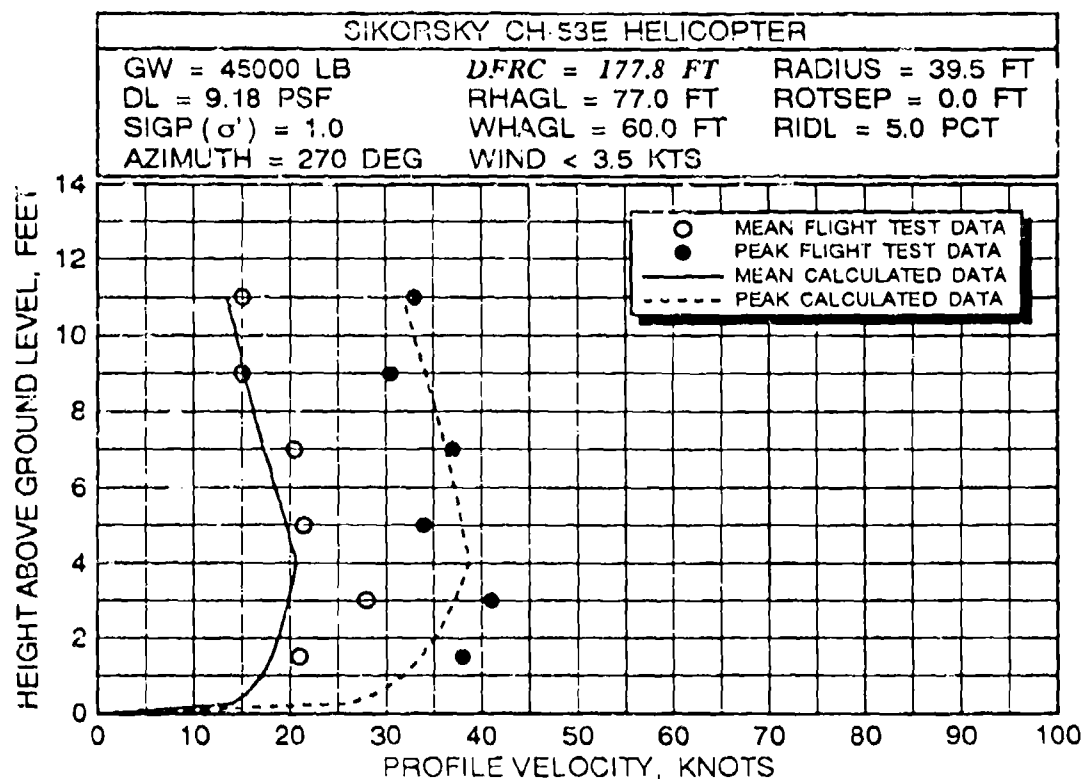
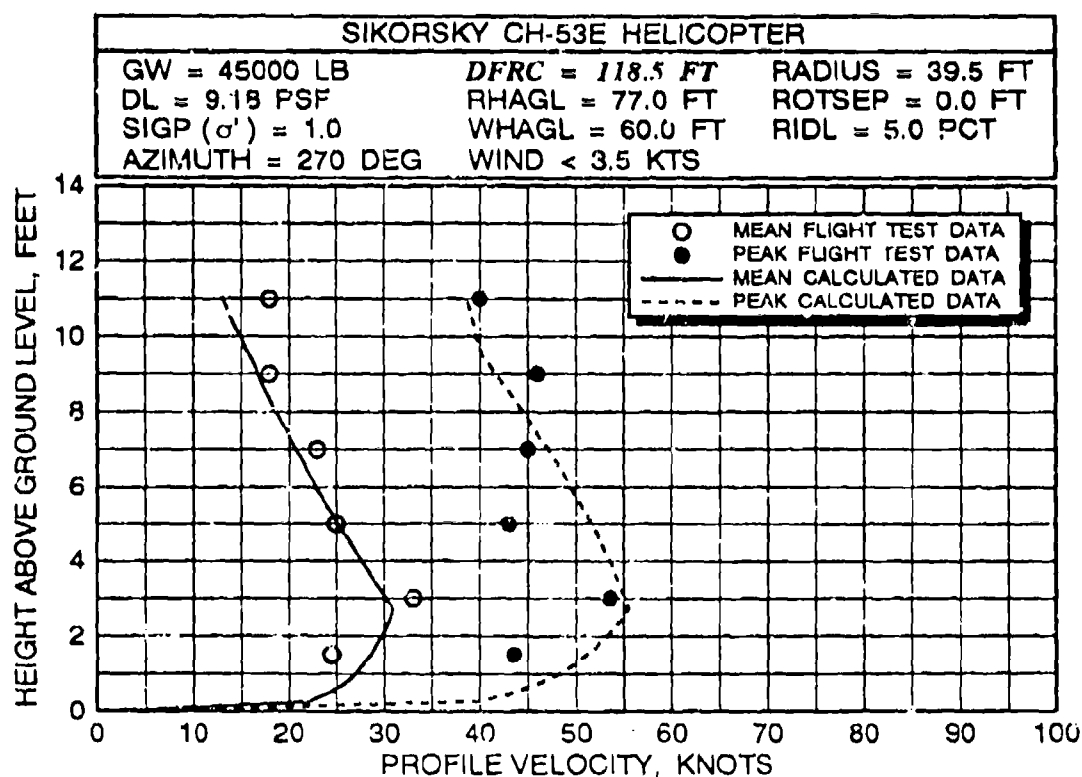


FIGURE B-9 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

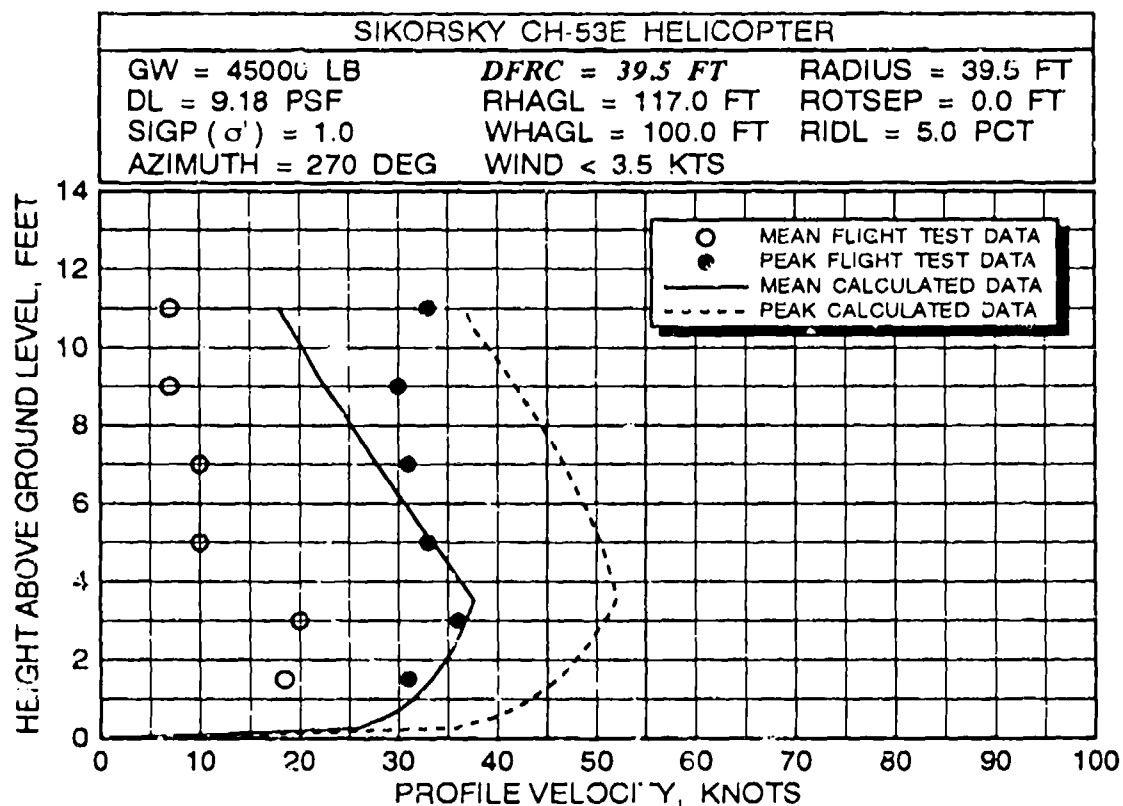
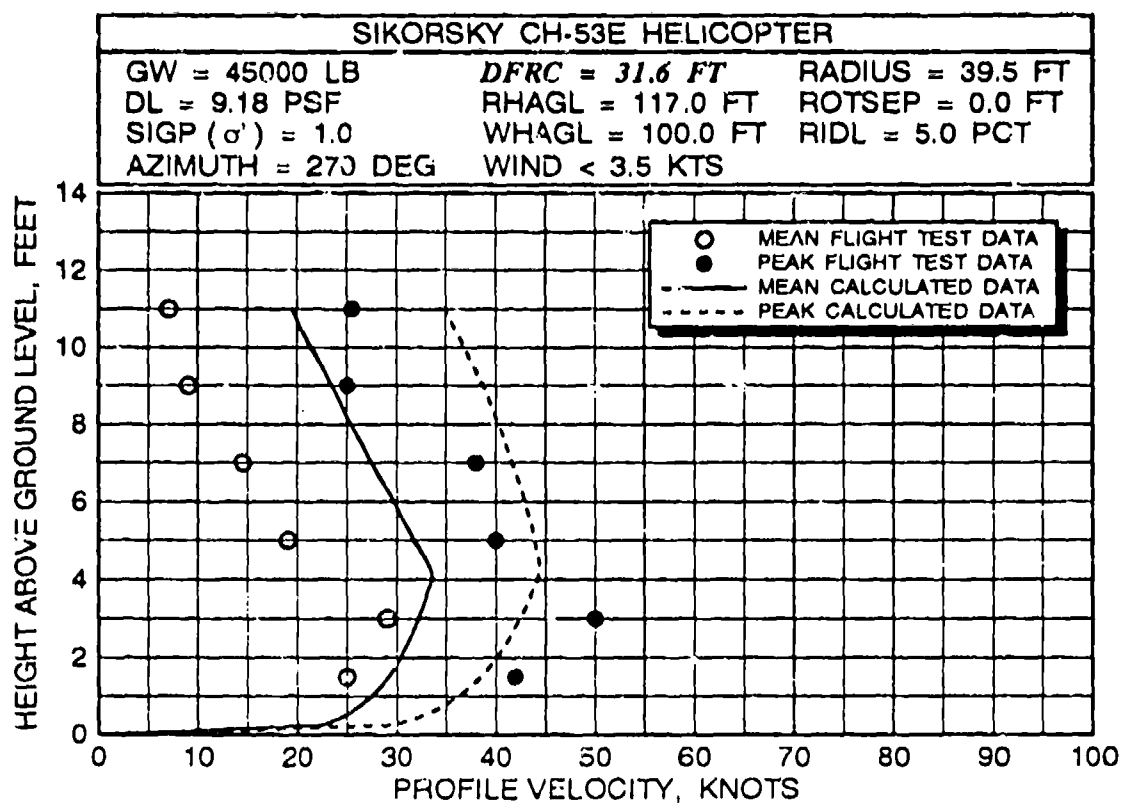


FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS

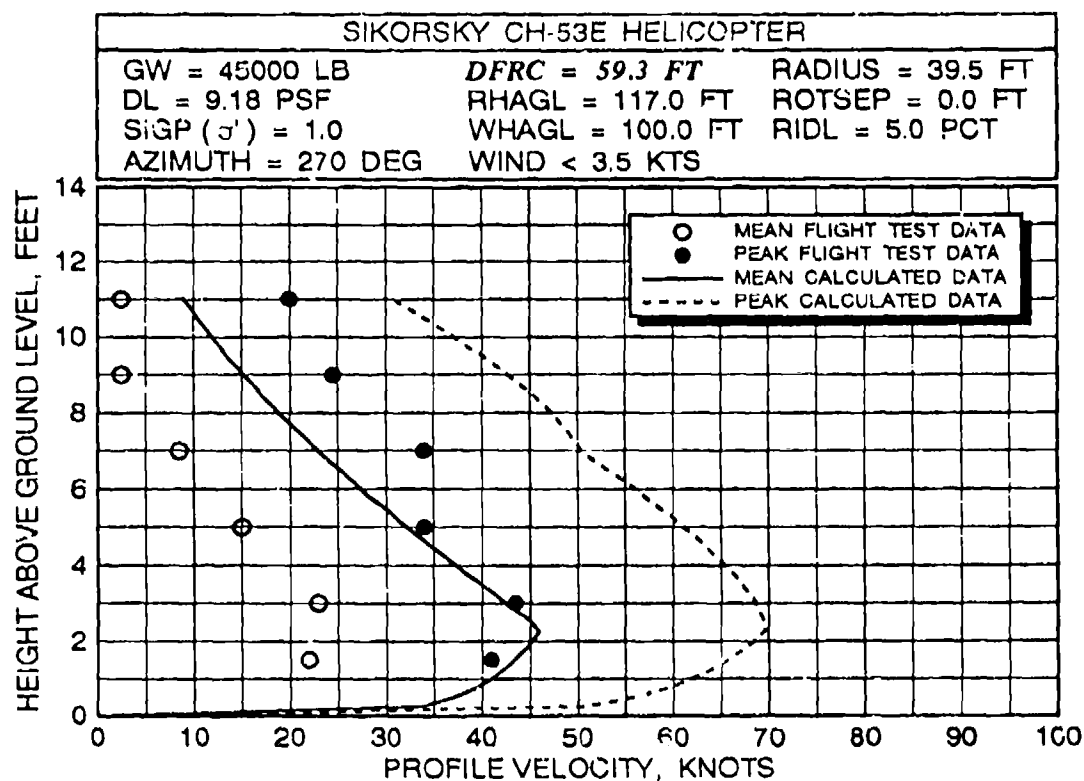
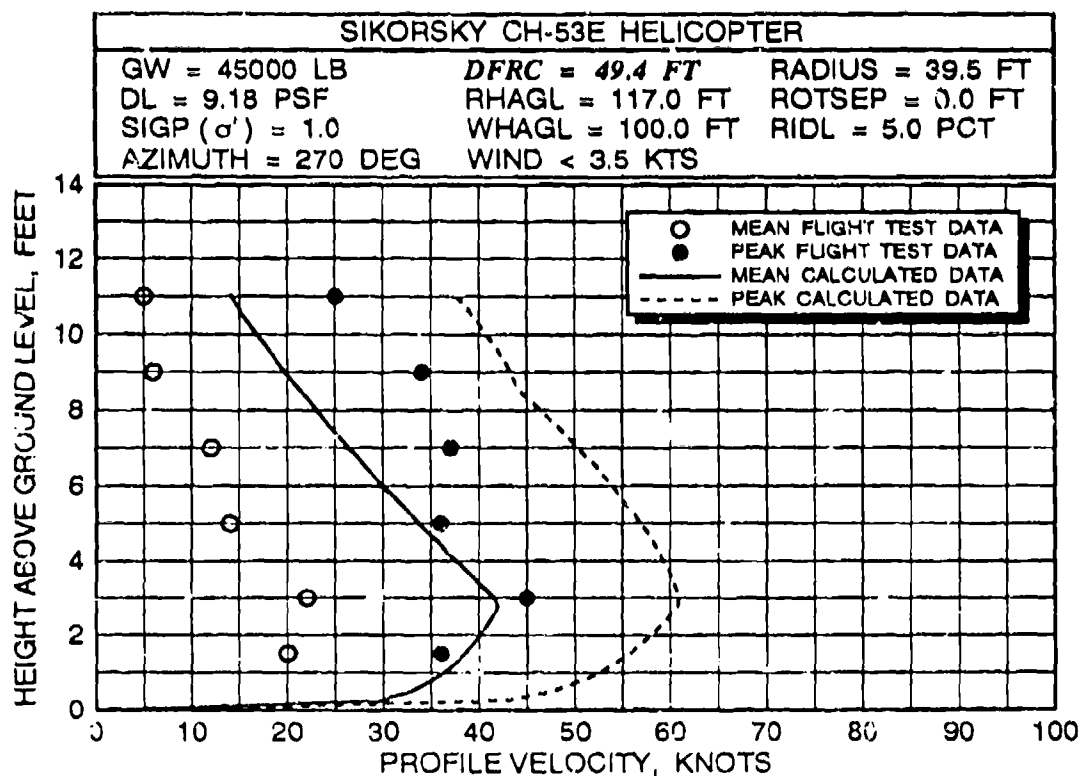


FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270-DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

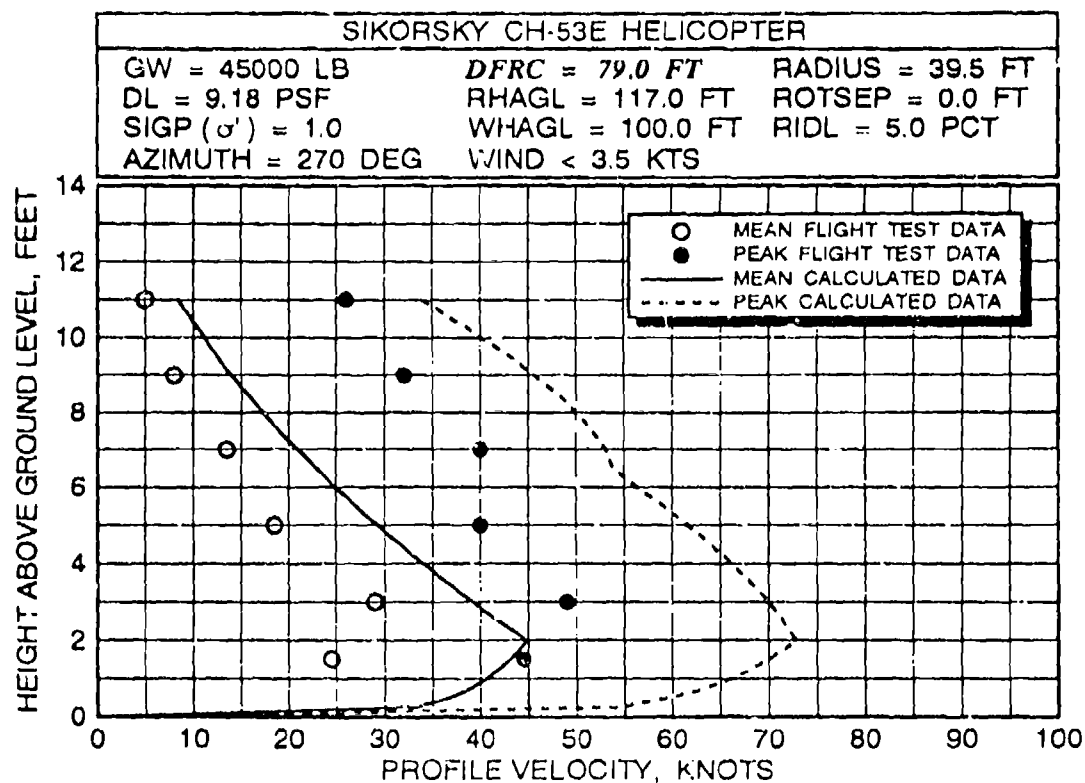
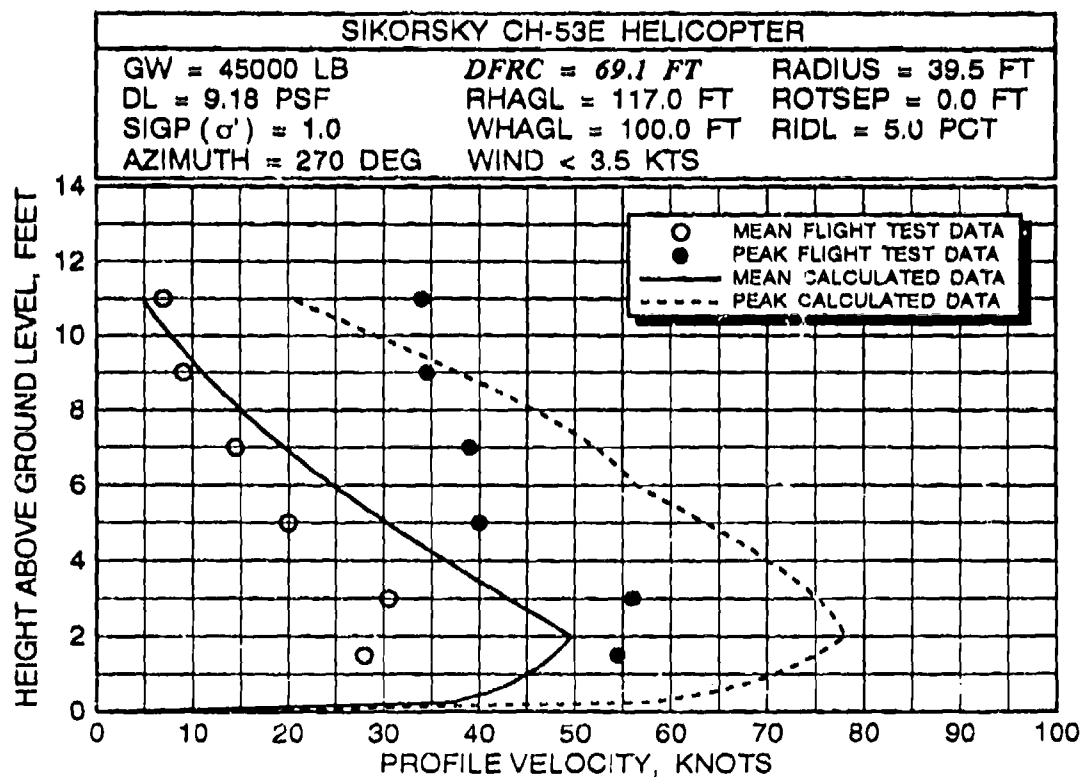


FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270- DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

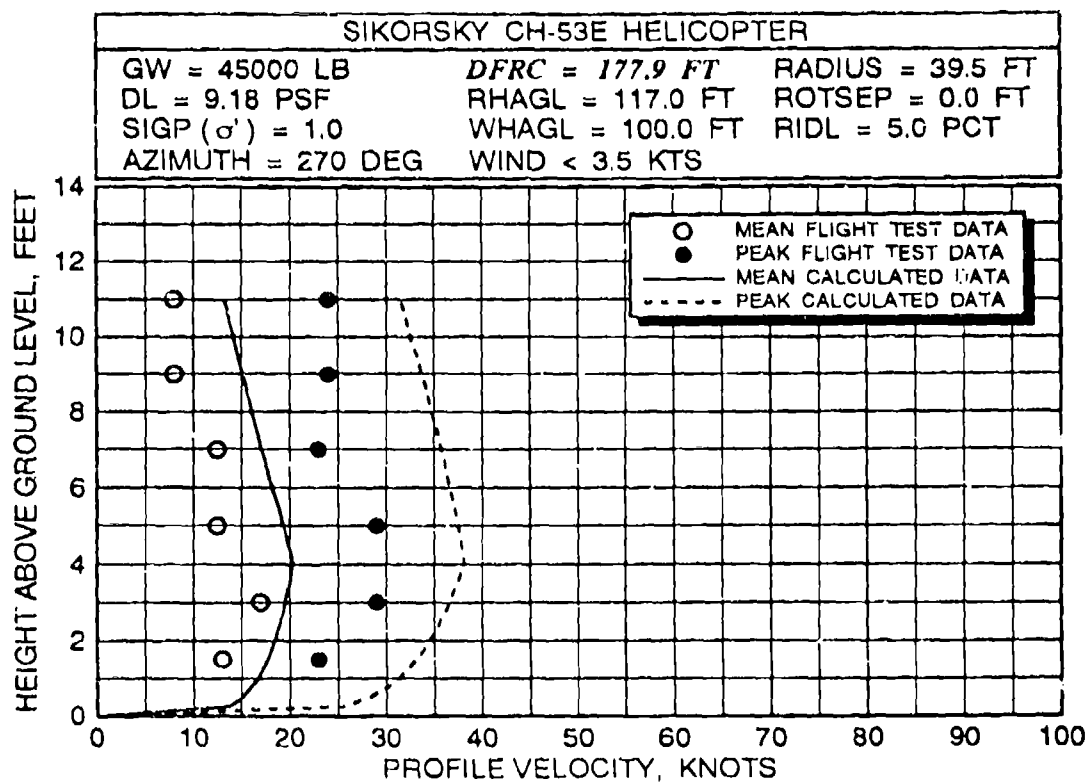
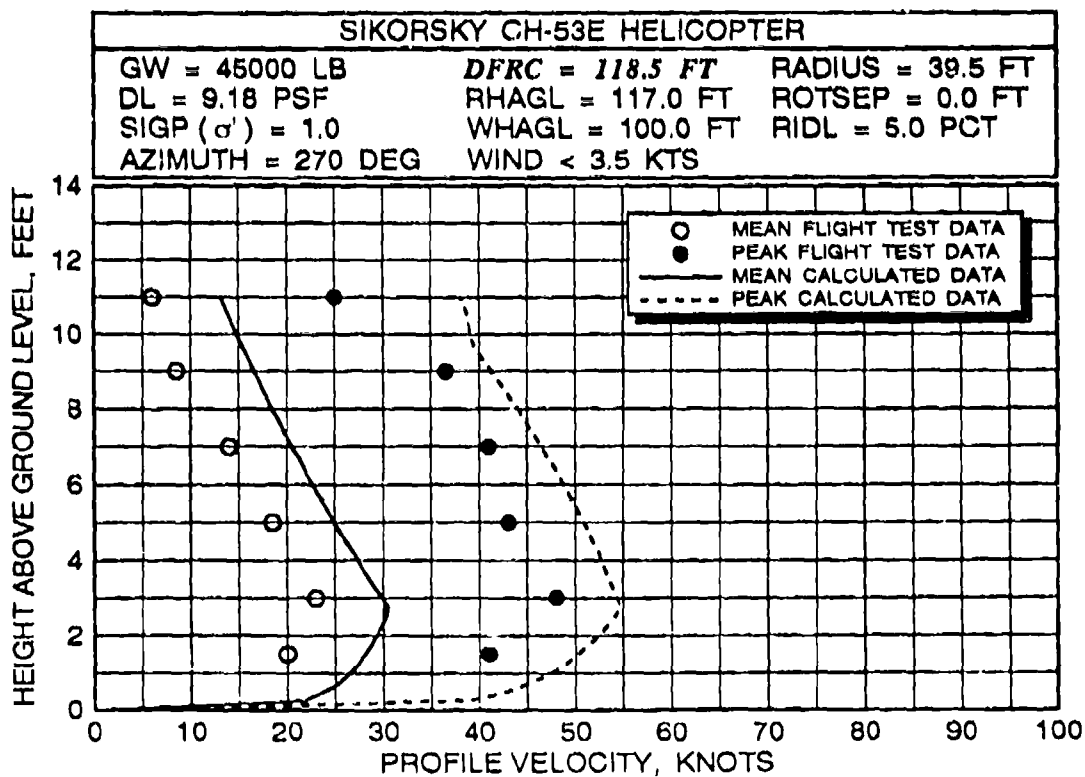


FIGURE B-10 CH-53E MEAN AND PEAK VELOCITY PROFILES FOR EIGHT 270- DEGREE AZIMUTH RADIAL STATIONS AT A ROTOR HEIGHT OF 117 FEET AND A GROSS WEIGHT OF 45,000 POUNDS (continued)

APPENDIX C

A COLLECTION OF REFERENCES PROVIDING INFORMATION OR FURTHER INSIGHT INTO XV ROTORWASH HAZARD ANALYSIS PROBLEM

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APPENDIX D USER'S GUIDE

D.1 ROTWASH PROGRAM USER'S GUIDE

The style of the ROTWASH user's guide presented in this appendix is primarily narrative. This format is designed to guide the reader through a step-by-step explanation on the use of each program software option. Example output from each option is presented exactly as it would be viewed by the user on a video terminal for reference purposes. Examples of user keyboard input are presented in <BOLD> text as an aid to the reader.

D.1.1 GETTING STARTED

The ROTWASH program is executed by typing the program name at the DOS system prompt:

<ROTWASH>

To avoid possible system errors, the user should execute the program from the directory containing the program (or set the appropriate DOS system PATH command). The user should also be aware that menu and data printouts to the screen will not work correctly unless the `device=C:\DOS\ANSI.SYS` command is contained in the CONFIG.SYS file.

The ROTWASH program responds with the screen output presented in figure D-1. This output is the ROTWASH program header page.

```
ROTWASH PROGRAM

ROTORCRAFT DOWNWASH HAZARD ANALYSIS

EMA / SYSTEMS CONTROL TECHNOLOGY
*** PROGRAM VERSION 2.1, APRIL 1993 ***

PRESS <RETURN>
```

FIGURE D-1 ROTWASH PROGRAM HEADER OUTPUT

After typing the carriage return <RETURN> or <ENTER> key, the user is asked to specify the path for ROTWASH program input and output (I/O). The only option for input at the present time is the terminal keyboard. This is specified by typing <CON> for console or keyboard (lower case inputs such as <con> are also permitted). Program output may be sent to one of three different locations. These output locations are:

<u>OUTPUT OPTION</u>	<u>TYPING COMMAND</u>
Screen	<CON>
Printer	<PRN>
Disk Plotting File	<PLT>

An example of the video screen output for this program menu is presented in figure D-2 where the <CON> option has been chosen for both input and output.

```
I/O CAN BE DIRECTED TO FILES OR DEVICES

VALID DEVICES ARE AS FOLLOWS:

      <CON>  ==>  CONSOLE
      <PRN>  ==>  PRINTER
      <PLT>  ==>  GRAPHICS FILE

ENTER INPUT FILE/DEV NAME ==> CON
ENTER OUTPUT FILE/DEV NAME ==> CON
```

FIGURE D-2 ROTWASH PROGRAM INPUT/OUTPUT CONTROL MENU

D.1.2 INPUT DATA REQUIREMENTS

Rotorcraft characteristics and atmospheric conditions that are common to all program options are input to the program using the master input data menu. Four basic configurations of rotor or propeller driven aircraft can be represented using this menu. These configurations include single and tandem rotor helicopters, tiltrotors, and twin-propeller tiltwings. This menu is presented to the user as shown in figure D-3 after the I/O menu is completed. The default values provided in the menu define the Bell XV-15 tiltrotor. Design data describing most other modern types of rotorcraft are provided in appendix A.

ROTWASH USER INPUT DATA MENU			
CODE	PARAMETER	VALUE	UNITS
A	NUMBER OF ROTORS (1 OR 2)	2	-ND-
B	HUB TO HUB ROTOR SEPARATION	32.2	FT
C	ROTOR RADIUS	12.5	FT
D	GROSS WEIGHT	13000.0	LB
E	FUSELAGE DOWNLOAD FACTOR	13.0	PCT
F	ROTOR HEIGHT ABOVE GROUND	37.0	FT
G	SHAFT TILT ANGLE (<20 DEG)	.0	DEG
H	AIR DENSITY RATIO	1.0000	ND
I	AMBIENT WIND (-10 TO 10 KT)	.0	KT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> D

GROSS WEIGHT = 13000.0

ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS ==> 13500.0

FIGURE D-3 MASTER INPUT DATA MENU

The first input data variable listed on the menu is the number of rotors (or propellers). This value will always be two except for single main rotor helicopters (the tail rotor is not considered a lifting rotor by the ROTWASH analysis). The next four menu variables define the design details of the rotorcraft configuration. These variables are the hub-to-hub separation distance for twin-rotor configurations (in feet), rotor radius (feet), rotorcraft gross weight (pounds), and the rotor-on-wing download factor (percent). The download factor represents the percent increase in hover rotor thrust required to overcome the rotor-induced vertical drag force on the airframe (where thrust is initially assumed to equal gross weight). For most helicopters, this value is less than 5 percent. Download on tiltrotors can generally be expected to vary from 8 to 13 percent because of the large wing area under the rotor.

The next two input data variables define the position of the rotor with respect to the ground plane. The rotor height (feet) is defined as the distance from the ground surface to the plane of the rotor. The mast angle (degrees) is defined as the tilt of the rotor plane with respect to the ground plane. The mast angle is defined as 0 degrees when the plane of the rotor is parallel to the ground plane and a positive angle is a forward tilt of the mast (which is presently limited in the program to 20 degrees). Since most rotorcraft hover with the plane of the rotor parallel to the ground, it is recommended that caution be exercised when non-zero values are used for mast angle. Non-zero uses of the variable might involve hover investigations for tiltwing aircraft

with the wing tilted forward (where a pitch fan provides the trim pitching moment). Also, limited rotorwash investigations for takeoff and landing maneuvers might be attempted if approximate rotor thrust levels are known for various segments of the maneuvers.

The last two input data variables on the menu define the atmospheric conditions. The air density ratio is defined as the ratio of the desired air density to the sea level standard air density ($0.0023769 \text{ slugs/foot}^3$). Ambient wind speed (knots) is specified by the user up to a limit of 10 knots. Values greater than this limit are believed to invalidate several empirically determined mathematical modeling assumptions (limits are discussed in sections 2 and 3 of Volume I of this report).

The mechanics of using the menu are quite simple. The user types in the code value for the variable to be changed and then types `<RETURN>`. The next prompt asks for the new parameter value. After this value and another `<RETURN>` are typed, the menu is rewritten to the screen with the new value. This simple process is continued until the user specifies each variable to its desired value. At this point, the `<RETURN>` key is typed by itself. This menu can also be reached from most of the other menus in the program whenever the user decides that the basic configuration needs to be modified. This is accomplished by typing `<N>` for NEW CASE when the option is offered.

D.1.3 ANALYSIS PROBLEM DEFINITION

After the master input data menu is completed, the user specifies the desired type of analysis option. Figure D-4 presents the program logic/comment menu and the associated list of default values. This menu has two groupings of parameters which need to be specified.

The first parameter on the menu specifies the choice of either the velocity calculation analysis option or the hazard analysis option. The velocity analysis option is the default option on the menu. This option is otherwise chosen by typing the code `<A>`, then `<RETURN>`, then `<V>`, and finally `<RETURN>`. The same process is used to specify the hazard analysis option except that `<H>` is substituted for `<V>` as the parameter value. The second menu parameter provides an interactive toggle switch for the option which writes out data files to disk for graphics programs. (This parameter is also offered as an option on the initial ROTWASH menu by typing `<PLT>`). There is no limit to the number of times this switch can be toggled. As long as the parameter has a `<Y>` or "yes" value, the user must specify output filenames before data files are written to disk. The user is not allowed to write over files previously written to disk by specification of the same filename twice.

ROTWASH PROGRAM LOGIC/COMMENT MENU			
CODE	PARAMETER		VALUE
A	ANALYSIS TYPE,	<V> OR <H>	V
B	GRAPHICS FILE,	<Y> OR <N>	N
USER INPUT COMMENTS (FOR "PRN" AND "PLT" OUTPUT)			
	<---	50 SPACES	---
C	XV-15 CHARACTERISTICS ARE USED AS INPUT DATA		
D	GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS		
ENTER CODE FOR DATA INPUT OR <RETURN> TO CONTINUE ==>			

FIGURE D-4 ROTWASH PROGRAM LOGIC/COMMENT MENU

The last two lines in the menu are used to specify user comments in all data files that are written to disk. These comments are also written out as header information on screen output sent directly to the printer. Both of the comment lines can be changed at any time during program execution. The only restriction is that the character strings on both lines be less than or equal to 50 characters. The arrowhead symbols above the comment lines in the menu define a 50-space line width.

If the velocity analysis option is specified, the user is then required to choose one of the four analysis options presented in figure D-5. Velocity analysis options reached through this menu are the:

1. simple wall jet (for both single and twin-rotor configurations),
2. interaction plane (twin-rotor only),
3. ground vortex (single rotor only), and
4. disk edge vortex (single rotor only).

SELECT TYPE OF FLOW TO BE ESTIMATED

WALL JET PROFILE,	TYPE <W>
INTERACTION PLANE PROFILE,	TYPE <J>
GROUND VORTEX,	TYPE <G>
DISK VORTEX,	TYPE <D>
TO EXIT PROGRAM,	TYPE <X>

ENTER DATA ENTRY CODE ==> W

FIGURE D-5 VELOCITY ANALYSIS OPTION MENU

Each of these four options is described with flowfield characteristics sketches in subsequent sections. For technical details and discussion on practical limitations of these options, the user is referred to Sections 2 and 3 of Volume I of this report. The choice of one of these menu options is made by typing the appropriate code and <RETURN>. If one of the five allowable characters is not chosen, the menu will reappear and the user will be forced to choose an acceptable option.

If the hazard analysis option is specified, the user is presented with the figure D-6 menu. This menu allows the user to choose either:

1. human overturning force/moment analysis, or
2. particulate cloud analysis.

Both of these analyses can be applied to either single or twin-rotor configurations. The mechanics of this menu operate exactly like those of the velocity analysis option menu.

D.1.4 THE WALL JET OPTION

Rotorwash velocity profiles are calculated for single main rotor helicopter configurations using the wall jet option. Velocity profiles along the 0- and 180-degree azimuths for tandem helicopters and the 90- and 270-degree azimuths for twin-rotor side-by-side configurations are also calculated using this option (90 degrees is out the right wing on a tiltrotor and 0 degrees is along the centerline of the fuselage for tandem rotor helicopters). Figure D-7 provides a three-dimensional view of

SELECT TYPE OF HAZARD

OVERTURNING FORCE/MOMENT,	TYPE <M>
PARTICULATE CLOUDS,	TYPE <C>
TO EXIT PROGRAM,	TYPE <X>

ENTER HAZARD CODE ==> M

FIGURE D-6 HAZARD ANALYSIS OPTION MENU

the rotorwash flowfields associated with both rotor configurations. Figure D-8 provides a cross-sectional view of the nondimensionalized ROTWASH wall jet velocity profile model. The program menu associated with the use of this option is presented in figure D-9.

The velocity profile status menu provides the user the option to specify four parameters before proceeding with detailed calculations. The horizontal distance on the ground from the center of the rotor to where the velocity profile should be calculated is the first parameter specified on the menu. Figure D-10 is provided to illustrate this geometry graphically using the Bell XV-15, which is the more complex example (flight test data results associated with this figure are documented in reference D-3). To specify the profile station position for the wall jet with the XV-15 (270-degree radial), the user would measure the distance from the aircraft centerline (DFAC) and subtract 16.1 feet (the distance from the centerline to the center of the rotor). The remaining two position-related parameters to be specified are the vertical calculation increment and the maximum height above ground level (AGL) to which the profile should be calculated. The default values for these three parameters are 50 feet, 1 foot, and 10 feet, respectively.

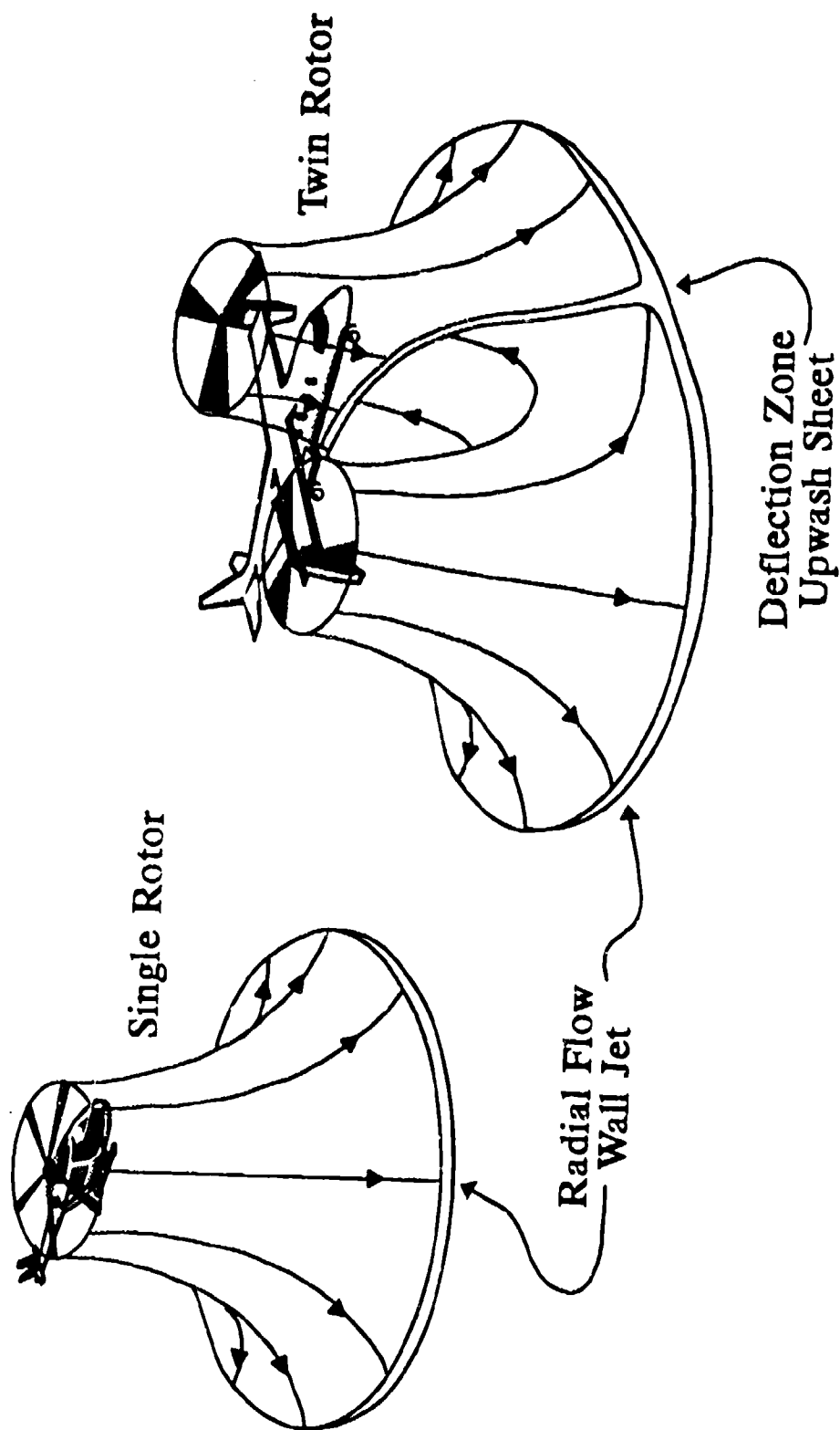


FIGURE D-7 ROTORWASH FLOW FIELDS OF SINGLE- AND TWIN-ROTOR CONFIGURATIONS OPERATING IN CLOSE PROXIMITY TO THE GROUND

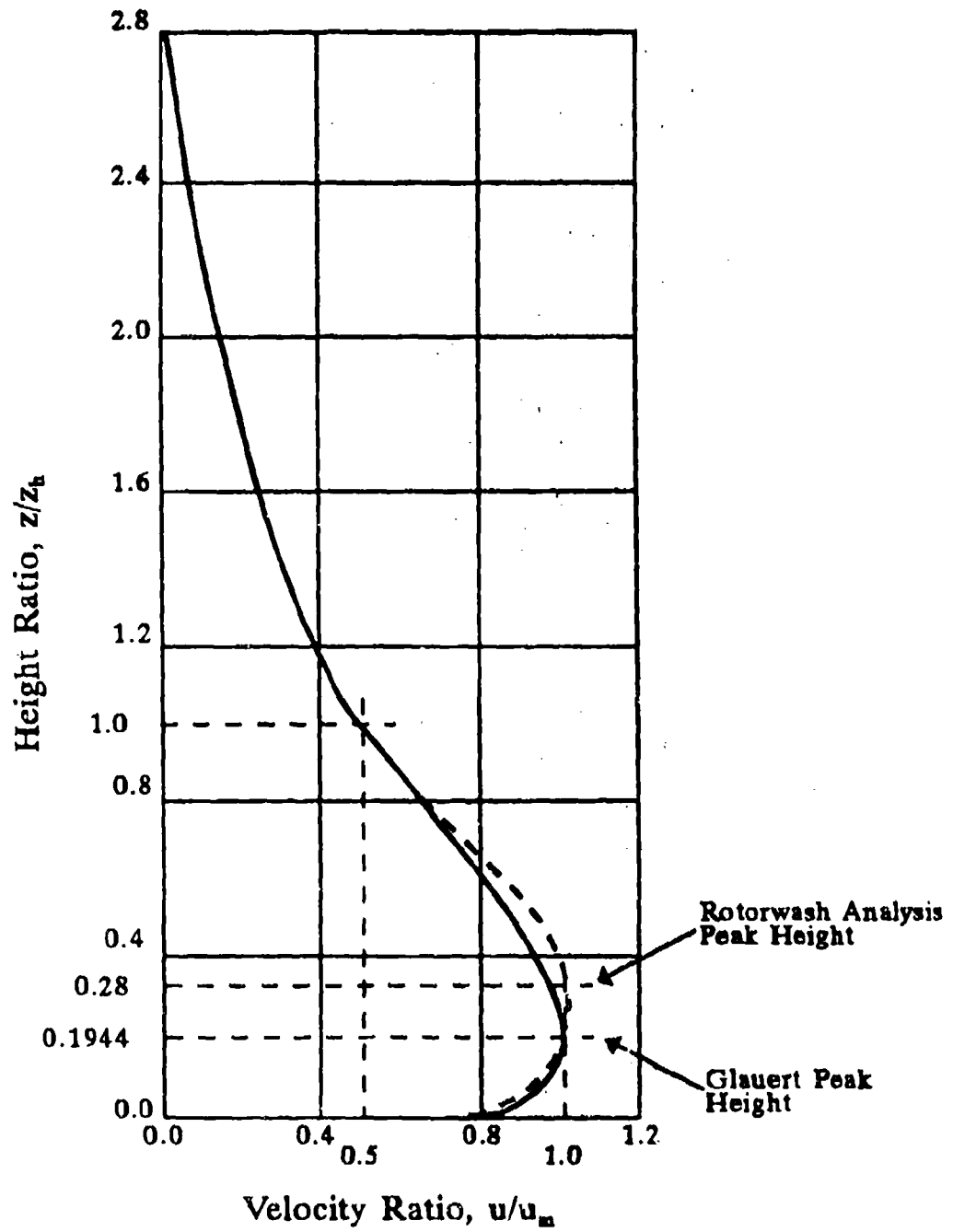


FIGURE D-8 NON-DIMENSIONAL WALL JET VERTICAL VELOCITY PROFILE

VELOCITY PROFILE STATUS MENU

CODE	PARAMETER	VALUE	UNITS
A	PROFILE STATION POSITION	50.00	FT
B	VERTICAL INCREMENT	1.00	FT
C	MAXIMUM PROFILE HEIGHT	10.00	FT
D	MINIMUM BOUNDARY LAYER HEIGHT	1.50	FT
E	DATA OUTPUT FILENAME	DFRC.PTS	

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

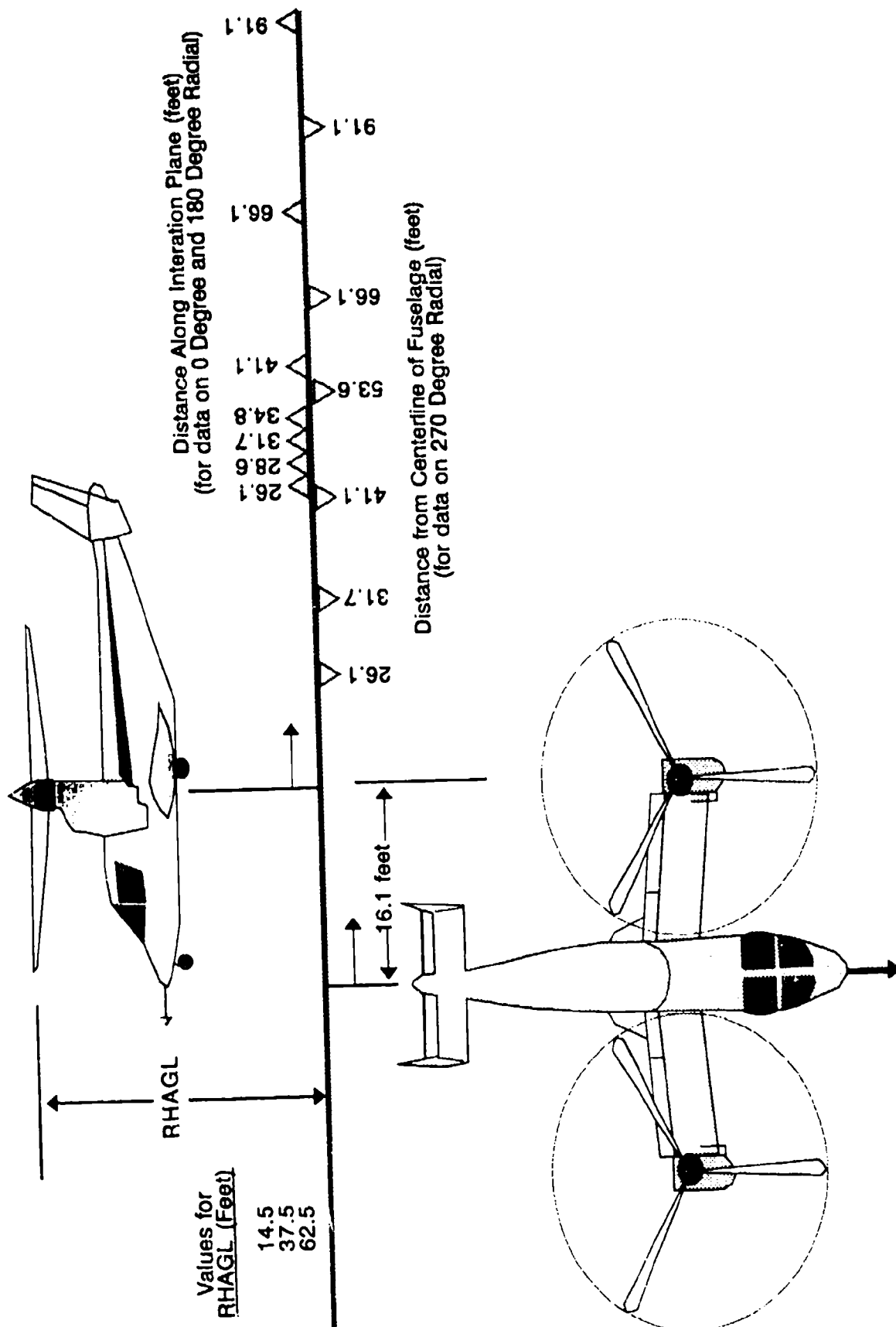
FIGURE D-9 VELOCITY PROFILE STATUS MENU

An option is also provided to allow the user to specify a minimum boundary layer height based on flight test data. The default value of 1.5 feet for this value will insure that the peak velocity on the profile is always equal to or greater than 1.5 feet (at very close positions to the rotor, the ROTWASH methodology often calculates an unrealistically thin boundary layer if a minimum limit is not specified). Each of the four parameters is input by typing the appropriate code, <RETURN>, the new input data value, and <RETURN> to end the sequence. The last parameter on the menu is the filename for data that is written to disk if the graphics file toggle switch is set to <Y>.

The wall jet velocity profile, calculated by the program using default inputs, is presented in figure D-11 when the <RETURN> key is typed by itself. Output from the analysis describes the shape of both the mean and peak velocity profiles; an example is presented in figure D-12 correlated with Bell XV-15 flight test data (this particular example correlates to a rotor height of 37.5 feet and a DFAC value of 66.1 feet on figure D-10).

The output format provides velocity profile data in units of either feet per second, knots, or pounds per square foot (also referred to as dynamic pressure).

If the specified increment in vertical height is small or the maximum calculated height is large, the quantity of data to be output to the screen may exceed the 10-line limit for 1 screen frame. When this situation occurs, the typing of <C> at the



D-11

FIGURE D-10 XV-15 FLIGHT TEST DATA MEASUREMENT LOCATIONS

SINGLE ROTOR VELOCITY PROFILE AT RADIUS = 50.0 FT						
PROFILE BOUNDARY HEIGHT = 11.49 FT						
HALF-VEL. HEIGHT = 4.10 FT						
MAX-VEL HEIGHT = 1.15 FT						
HEIGHT (FT)	MEAN VELOCITY		PEAK VELOCITY		MEAN Q	PEAK Q
	(FPS)	(KN)	(FPS)	(KN)	(PSF)	(PSF)
.00	.000	.000	.000	.000	.000	.000
1.00	42.306	25.077	78.945	46.796	2.127	7.407
2.00	40.282	23.878	81.231	48.151	1.928	7.842
3.00	32.043	18.994	74.263	44.021	1.220	6.554
4.00	24.823	14.714	65.002	38.531	.732	5.021
5.00	18.565	11.005	59.944	35.533	.410	4.270
6.00	13.240	7.848	51.299	30.408	.208	3.128
7.00	8.829	5.233	39.909	23.657	.093	1.893
8.00	5.319	3.153	27.477	16.288	.034	.897
9.00	2.700	1.600	15.691	9.301	.009	.293
10.00	.964	.571	6.222	3.688	.001	.045
TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>						

FIGURE D-11 WALL JET VELOCITY PROFILE OUTPUT FORMAT

prompt (at the bottom of the screen) results in the next 10 lines of data being written to the screen. If the code value <P> is typed, the program returns to the wall jet analysis menu. The typing of code <N> results in the program returning to the master input data menu. If the code <X> is typed, the program returns to the DOS system prompt.

Flight test data, correlated with output from the wall jet option, are presented in section 3 of Volume I of this report for the Bell XV-15, Bell-Boeing MV-22, Sikorsky CH-53E, Sikorsky SH-60B, and Canadair CL-84. Based on the correlation conducted for references D-1 and D-2, it is generally recommended that the wall jet option be used for calculation of velocity profiles at distances greater than 1.5 times the rotor radius from the center of the rotor. At distances less than this value, the mathematical model is not detailed enough to predict rotorwash flowfield characteristics accurately. This limitation is not serious because distances closer to the rotor tip than 1.5 times the rotor radius have little practical reason for being analyzed for rotorwash effects on the environment. Collision avoidance with respect to objects in close proximity to the rotorcraft is the critical issue at this close a distance.

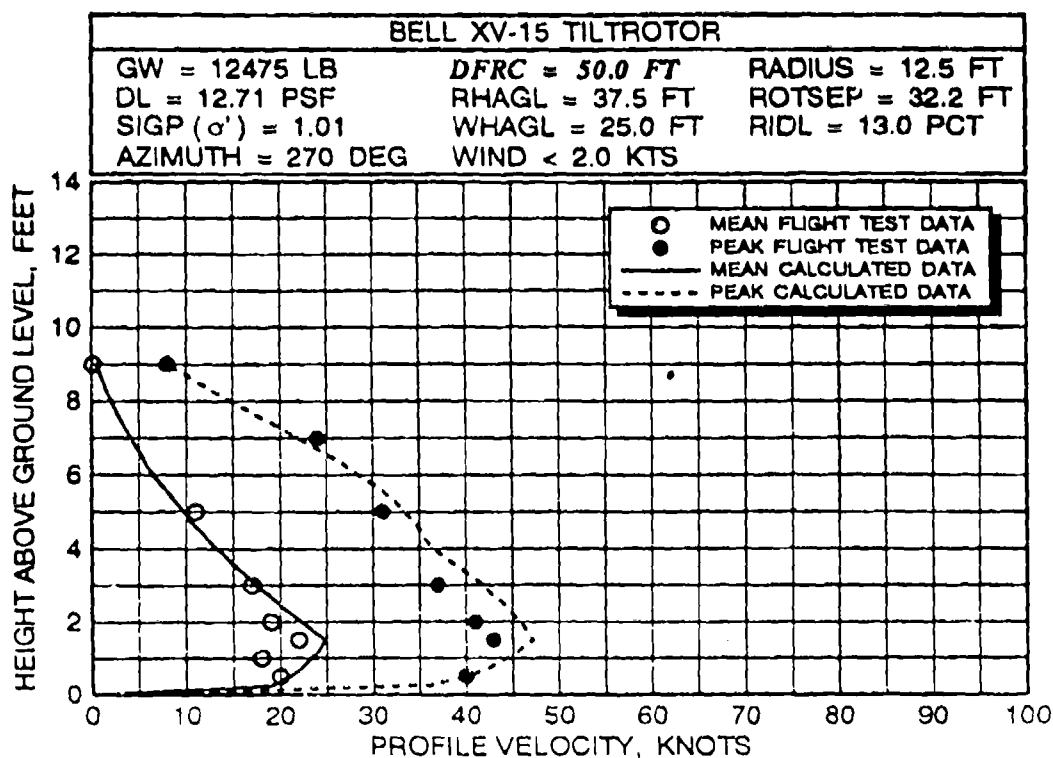


FIGURE D-12 XV-15 VELOCITY PROFILE CORRELATION

D.1.5 THE TWIN-ROTOR INTERACTION PLANE OPTION

The twin-rotor interaction plane option calculates the velocity profile contained in the plane which is oriented perpendicular to the ground and to the line segment which connects the center of both rotor hubs (refer to figure D-1). After choosing the interaction plane option on the velocity analysis option menu, the user must specify the same parameters on the velocity profile status menu that are required with the wall jet option. The only difference between the parameters is the reference position for specification of the horizontal location of the velocity profile with respect to the rotor (the first menu option). For the interaction plane analysis, this distance is referenced as 0 at the intersection of the interaction plane and the line connecting the rotors and not directly to the center of one of the two rotors (i.e., the input value for distance along the interaction plane (DAIP) for a tiltrotor is along a line that is an extension of the fuselage centerline as seen in figure D-10). No velocity profile differences are assumed to exist by the mathematical model for points equidistant along the interaction plane but on opposite sides of the line connecting the rotors. For a tiltrotor, this means that the calculated velocity profiles both

directly in front of and directly aft of the aircraft are the same when equidistant along the interaction plane.

Example output from the interaction plane option is presented in figure D-13. This data format closely resembles that of the wall jet option except that both horizontal and vertical velocity profile components are calculated. The horizontal velocity component is identified by the "H" in the column following the height column and the vertical component by the "V". The mechanics for viewing data on the screen (if more data exist than will fit on one screen frame) and for transferring to other menus are exactly as are described for the wall jet option.

TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE AT STATION = 50.0 FT							
HEIGHT (FT)		MEAN VELOCITY (FPS) (KN)		PEAK VELOCITY (FPS) (KN)		MEAN Q (PSF)	PEAK Q (PSF)
.00	H	.000	.000	.000	.000	.000	.000
	V	.000	.000	.000	.000	.000	.000
1.00	H	63.626	37.715	103.992	61.643	4.811	12.852
	V	21.760	12.899	35.555	21.082	.563	1.503
2.00	H	66.665	39.517	108.960	64.538	5.282	14.110
	V	24.133	14.305	39.443	23.381	.692	1.849
3.00	H	65.800	39.004	107.545	63.749	5.146	13.746
	V	25.136	14.900	41.082	24.352	.751	2.006
4.00	H	64.912	38.478	106.093	62.889	5.008	13.377
	V	26.094	15.468	42.649	25.281	.809	2.162
TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>							

FIGURE D-13 INTERACTION PLANE VELOCITY PROFILE OUTPUT FORMAT

Output from the interaction plane option, correlated with XV-15 flight test data, is presented in figure D-14 as an example. These data are excerpted from reference D-2. Other original flight test data for both the Bell XV-15, Bell-Boeing MV-22, and Canadair CL-84 (tiltwing) are documented in section 3 of Volume I of this report.

Several practical recommendations need to be noted for users of the interaction plane option. When analyzing tiltrotor and tiltwing configurations, the user must be careful to avoid choosing analysis locations that are coincident with components of the nose or tail structure on the aircraft. Also, locations in close proximity to the nose or tail of a real aircraft should not be expected to have rotorwash flowfield characteristics identical to calculated velocity profiles. At these locations unmodeled airframe aerodynamic interferences significantly influence the rotorwash flowfield structure. Flight test data

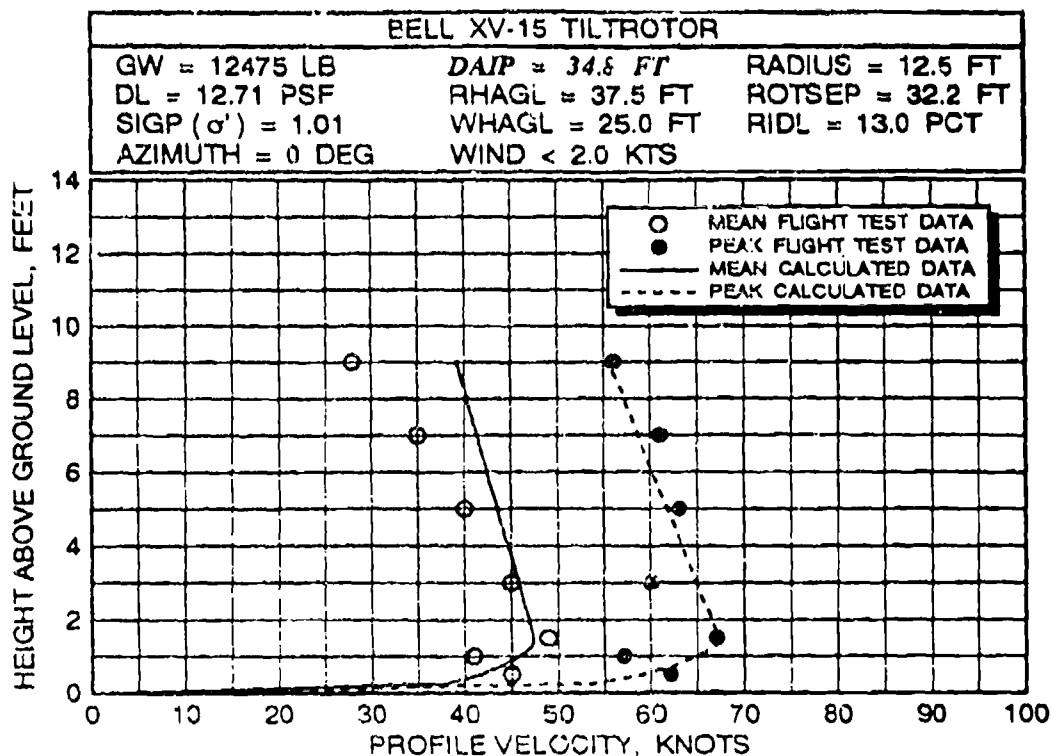
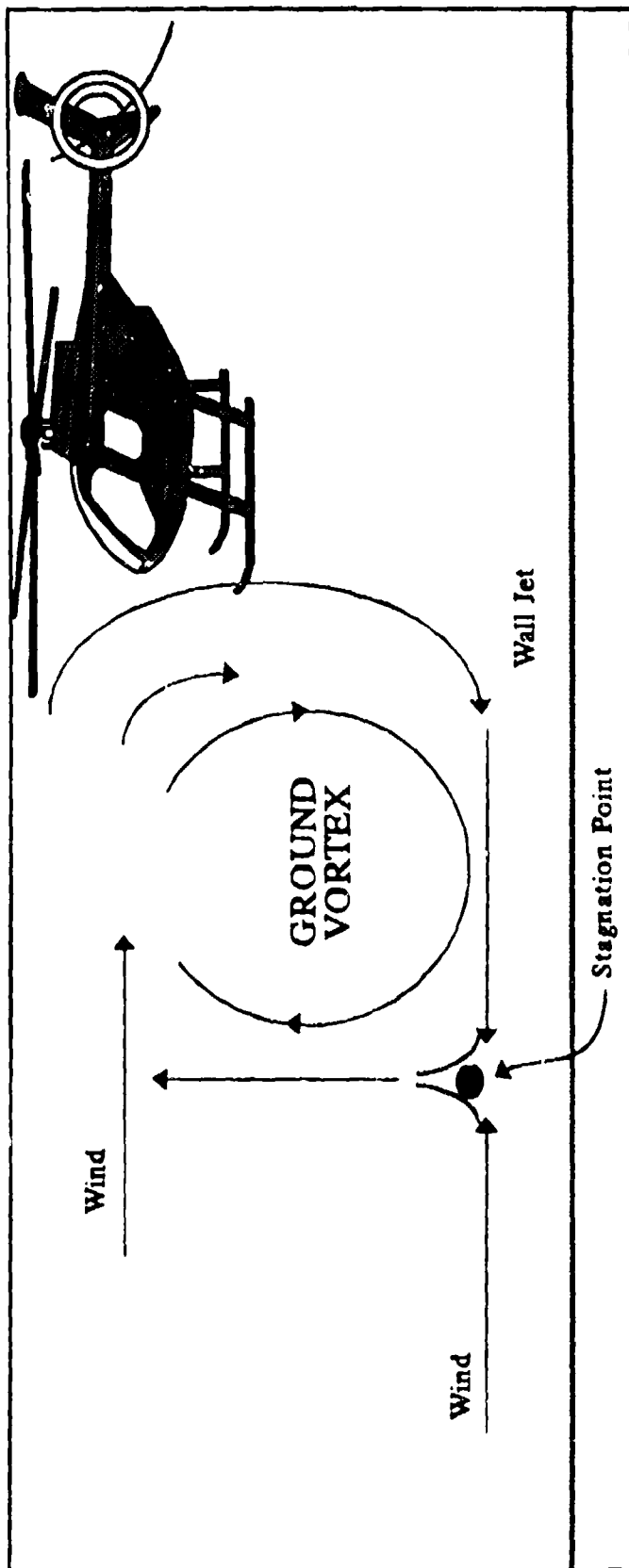


FIGURE D-14 XV-15 INTERACTION PLANE VELOCITY PROFILE CORRELATION

obtained from the XV-15, MV-22, and CL-84 indicate that measured mean and peak velocity profiles at points equidistant along the interaction plane (both in front of and aft of an actual aircraft) often do not yield identical results as might be expected. Therefore, output from this analysis option should be calibrated with flight test data whenever possible in an attempt to determine whether positions forward or aft of the aircraft may be more critical for analysis.

D.1.6 GROUND VORTEX ANALYSIS OPTION

A ground vortex structure is formed when ambient wind and/or rotorcraft translational velocity overcome the rotor-induced wall jet flowfield. A diagram of the ground vortex is presented in figure D-15. Due to the elementary nature of the mathematical model formulation used in the ROTWASH program, the ground vortex option should be used with caution. As discussed in section 2 of Volume I of this report, almost no test data exist to validate the mathematical model. Also, the single main rotor helicopter is the only configuration that can be analyzed with the model as presently formulated. Since all examples presented up to this point in the user's guide have been for the XV-15, it is necessary to define input data for a single main rotor helicopter



D-16

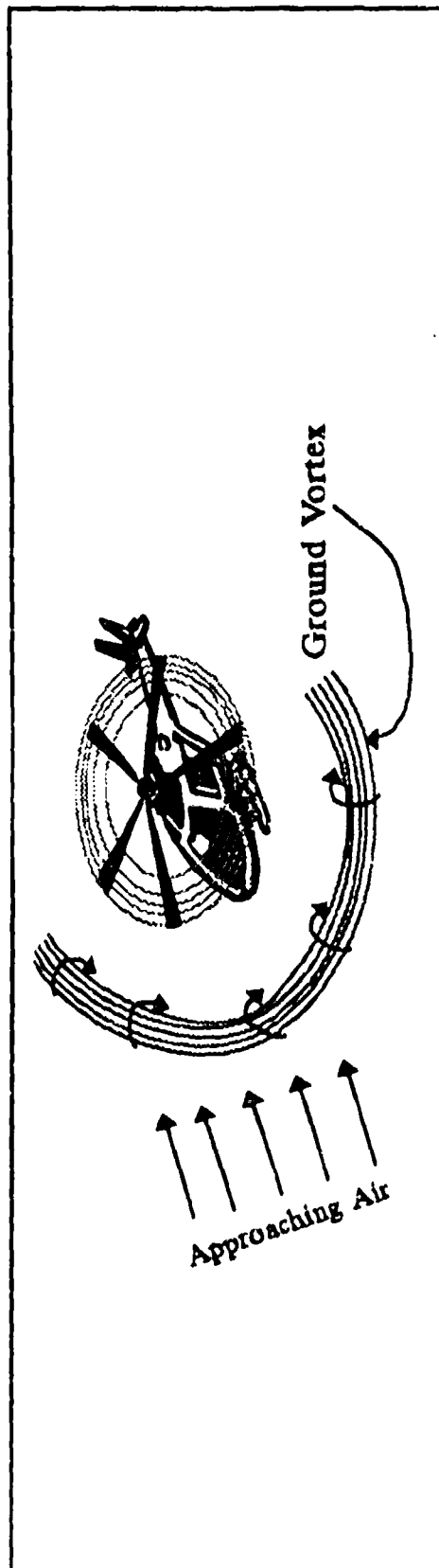


FIGURE D-15 GROUND VORTEX STRUCTURAL CHARACTERISTICS

ROTWASH USER INPUT DATA MENU			
CODE	PARAMETER	VALUE	UNITS
A	NUMBER OF ROTORS (1 OR 2)	1	-ND-
B	HUB TO HUB ROTOR SEPARATION	.0	FT
C	ROTOR RADIUS	39.5	FT
D	GROSS WEIGHT	56000.0	LB
E	FUSELAGE DOWNLOAD FACTOR	5.0	PCT
F	ROTOR HEIGHT ABOVE GROUND	30.0	FT
G	SHAFT TILT ANGLE (<20 DEG)	.0	DEG
H	AIR DENSITY RATIO	1.0000	ND
I	AMBIENT WIND (-10 TO 10 KT)	.0	KT
ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>			

FIGURE D-16 CH-53E INPUT DATA FOR THE GROUND VORTEX EXAMPLE

before the ground vortex option is explained in detail. The Sikorsky CH-53E configuration has been chosen for this task. The main input data menu for this configuration, as typed into the program, is presented in figure D-16.

The ground vortex analysis option is specified by selection of the character <G> on the velocity analysis option menu as shown in figure D-5. The user is then required to complete the ground/disk vortex input data menu which is presented in figure D-17. Two of the parameters specified on this menu are rotorcraft configuration parameters. These parameters are the rotor tip speed (feet/second) and the number of rotor blades. The next parameter to be specified is the rotorcraft translational velocity with respect to the surrounding air mass (i.e., an input of 15 knots can be either 15 knots ground speed on a no-wind day or 0 knots ground speed on a day with a 15-knot headwind). Each of these values is input with the keyboard using the same techniques that have been previously discussed.

The next four menu parameters define the position in three-dimensional space (feet) where the velocity profile will be calculated (see figure D-18). The positive directions for the coordinate system are aft and right from the center of the rotor. Therefore, in order to calculate a slice of the ground vortex directly in front of the rotor, a negative X-value (longitudinal position) is input along with a zero Y-value (lateral position). The Z-axis increment (feet) and maximum calculation height (feet) parameters define the number of points that are calculated between ground level and the maximum height of interest.

**GROUND/DISK VORTEX INPUT DATA MENU
(FOR SINGLE MAIN ROTOR HELICOPTERS ONLY)**

CODE	PARAMETER	VALUE	UNITS
A	ROTOR TIP SPEED	733.00	FPS
B	NUMBER OF ROTOR BLADES	7.00	-ND-
C	TRANSLATIONAL SPEED	16.00	KTS
D	XT POSITION	-60.00	FT
E	YT POSITION	.00	FT
F	ZT CALCULATION INCREMENT	2.00	FT
G	MAXIMUM CALCULATION HEIGHT	20.00	FT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

FIGURE D-17 GROUND/DISK VORTEX INPUT DATA MENU

After each input data parameter has been specified, the user types the <RETURN> key to initiate the analysis. The response of the program is to list three calculated parameters which are followed by a prompt. An example of this response is provided in figure D-19. The calculated values are the nondimensionalized rotor height above ground and two advance ratio parameters. The program prompt following the screen output requires the user to input the ground vortex strength ratio which is obtained from the graph in figure D-20 using the three calculated parameters. Background on the use of this figure is discussed in section 2 of Volume I of this report. The limits presented on the graph in figure D-20 define the advance ratio range wherein the ground vortex would be expected to occur. At advance ratios much less than 0.035, the ground vortex does not have favorable conditions for formation. At advance ratios slightly greater than 0.055, the ground vortex is dispersed by the rotor because the translational velocity relative to the air mass is too high for the vortex to maintain position. After the user has entered the ground vortex strength ratio, the program calculates the ground vortex circulation and the position of the ground vortex core with respect to the axis system presented in figura D-18. This output is also presented in figure D-19 below the prompt for the ground vortex strength ratio.

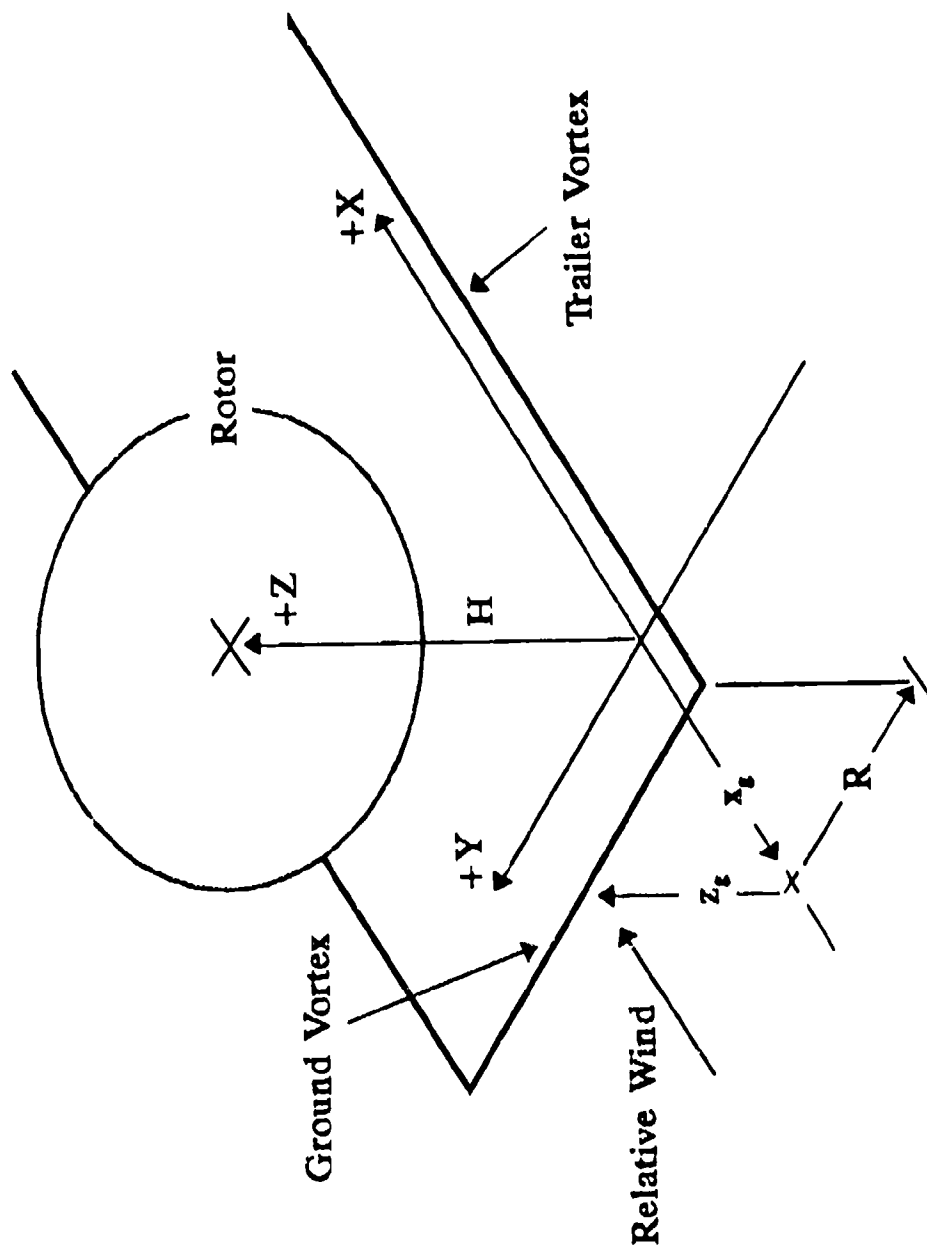


FIGURE D-18 HORSESHOE VORTEX GEOMETRY FOR CALCULATION OF GROUND VORTEX HAZARD POTENTIAL

ROTOR HEIGHT ABOVE GROUND H/D	.3797
ADVANCE RATIO MU-STAR	.5373
ADVANCE RATIO MU	.0368

ENTER GROUND VORTEX STRENGTH RATIO
(SEE FIGURE D-20) ==> 3.

GROUND VORTEX CORE POSITION

X-LOCATION (XXGV)	=	-59.14	FT
Y-LOCATION (ZZGV)	=	9.15	FT

GROUND VORTEX CIRCULATION = 732.35 FT**2/SEC

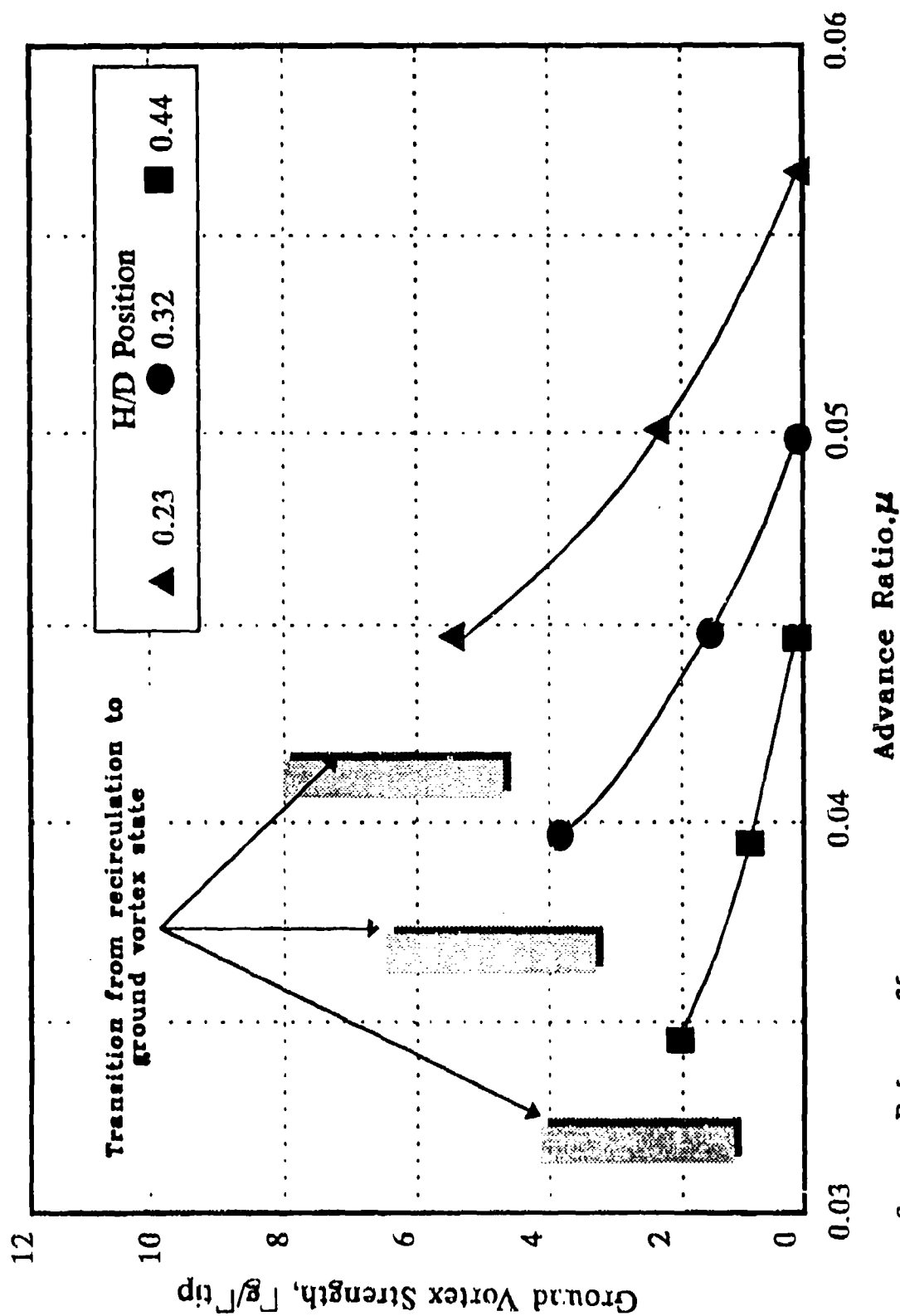
PRESS <RETURN> TO CONTINUE

FIGURE D-19 GROUND VORTEX ANALYSIS INTERMEDIATE OUTPUT

Engineering data from the ground vortex analysis option is obtained by typing the <RETURN> key after the vortex position parameters are displayed. An example of the output format is presented in figure D-21. Calculated field velocities at the various points along the profile Z-axis are presented in both a vectorial XYZ component format and as a total resolved magnitude in units of feet per second and knots. These same data are also provided to the user as dynamic pressures in units of pounds per square feet.

D.1.7 DISK EDGE VORTEX ANALYSIS OPTION

The disk edge vortex analysis option was developed to provide a capability to estimate the strength of trailing vortices behind helicopters in forward flight as described by figure D-22. Like the ground vortex option, this option is limited to use with the single main rotor helicopter configuration. Approximations of vortex core size are not calculated by the mathematical model and must be estimated using flight test data. Available flight test data are presented in section 3.6 of Volume I of this report. All examples presented in the user's guide for this analysis option utilize the same CH-53E input data array that was described previously.



Source: Reference 35.

FIGURE D-20 CALCULATED GROUND VORTEX CIRCULATION STRENGTH

HEIGHT		MEAN VELOCITY		MEAN Q
(FT)		(FPS)	(KN)	(PSF)
.00	X	-24.582	-14.572	.718
	Y	.000	.000	.000
	Z	.000	.000	.000
	T	24.582	14.572	.718
2.00	X	-25.790	-15.288	.790
	Y	.000	.000	.000
	Z	1.013	.601	.001
	T	25.810	15.299	.792
4.00	X	-30.173	-17.886	1.082
	Y	.000	.000	.000
	Z	2.868	1.700	.010
	T	30.309	17.966	1.092

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-21 GROUND VORTEX VELOCITY FIELD OUTPUT DATA

Execution of the disk edge vortex option is initiated by choosing <D> on the velocity analysis option menu shown in figure D-5. The ground/disk vortex input data menu, shown in figure D-17, must then be completed as described in the previous section. All sign conventions used in the specification of locations for the calculation of field velocities are the same as for the ground vortex option. After the input data menu is completed, the analysis option is executed by typing the <RETURN> key.

The initial program response, figure D-23, is to write to the screen the calculated values for the vortex circulation and the settling angle of the trailing vortex components as defined in figure D-22 for a forward-flight velocity of 50 knots and a rotor height above ground of 100 feet. When executing this option, it is important that the user confirm that the calculated settling angle is less than approximately 20 degrees. At settling angles larger than this value, the airspeed of the helicopter is probably too slow to sustain the formation of the trailing edge vortex system which is predicted using this mathematical model, and results should be considered suspect. User specified velocity field calculations are presented after the <RETURN> key is typed in the same format as was discussed with the ground vortex option. An example output for the CH-53E is presented in figure D-24.

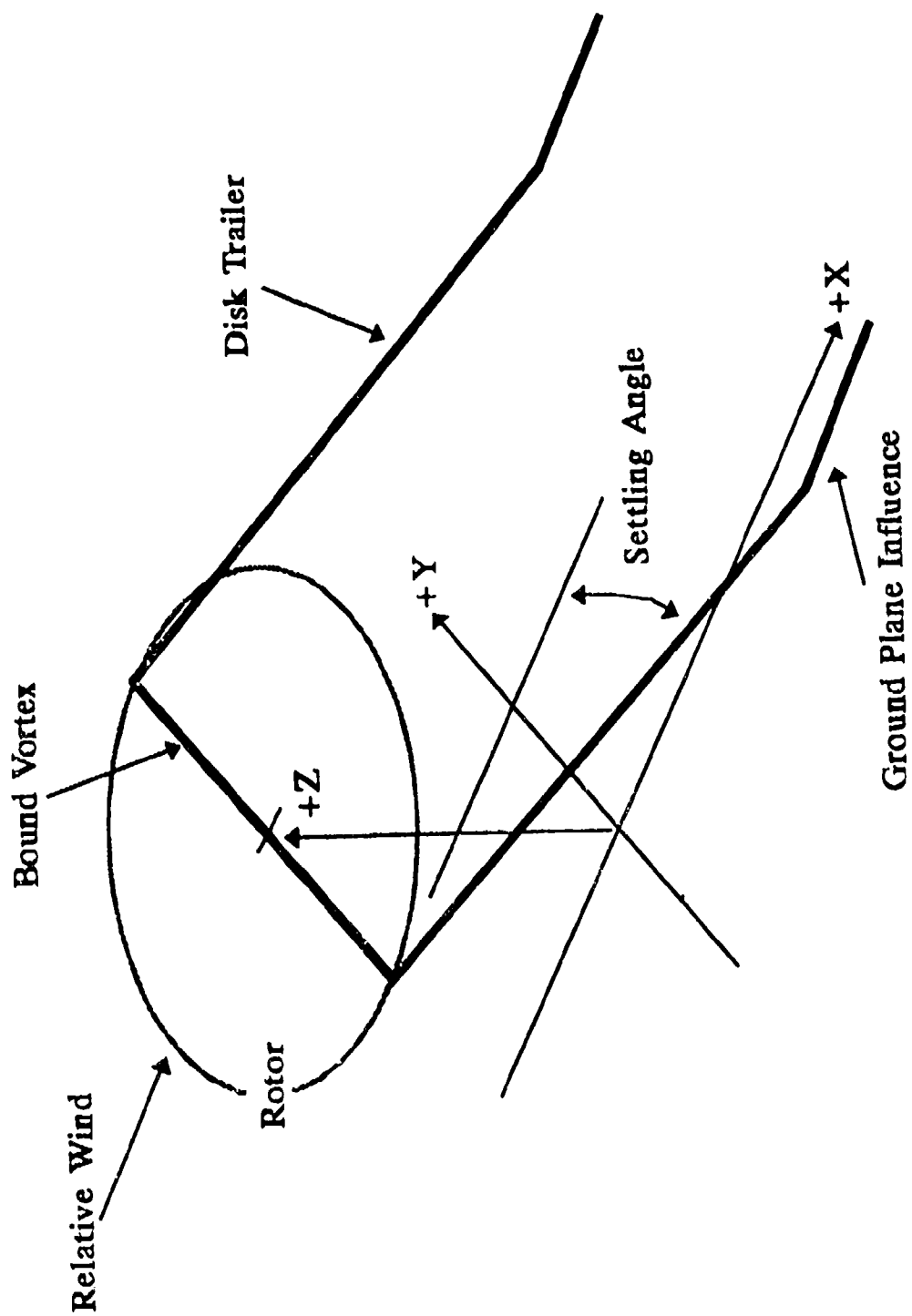


FIGURE D-22 HORSESHOE VORTEX GEOMETRY FOR CALCULATION OF FORWARD FLIGHT WAKE HAZARD POTENTIAL

Other features of the mathematical model which should be noted are described below.

1. The calculated trailing vortex strength does not decay as a function of increasing distance from the helicopter or with increasing time. This weakness in the model will affect correlation with flight test data and could result in predicted values that are greater than measured values for field velocities.
2. The decay of the trailing vortex structure after impingement with the ground is not modeled. Any prediction of field velocities behind the initial impingement point should not be considered valid. The location of the impingement point with respect to the ground and the location of points specified for velocity field calculations must be checked by hand calculation to ensure that geometry constraints are not violated. This is accomplished by using the rotor height and the settling angle to calculate the horizontal distance behind the helicopter where the impingement occurs.

D.1.8 PERSONNEL OVERTURNING FORCE AND MOMENT ANALYSIS

The personnel overturning force and moment analysis model is formulated for use with both the single main rotor and twin-rotor configurations. The initial task of the model is to calculate the velocity profile for a specified location. The calculated velocity profile is then integrated over the projected area of a human body to obtain estimates of the applied aerodynamic force and moment. This analysis technique is summarized in figure D-25.

Use of the overturning force and moment option is initiated by choosing <H> (for hazard) on the program logic/comment menu. This is followed by the choice of <M> (for overturning force/moment) on the hazard analysis option menu as shown in figure D-6. The user then specifies the parameters listed on the overturning force and moment data menu presented in figure D-26. The first parameter on this menu specifies the use of either the wall jet or the interaction plane analysis for creation of velocity profile data. The second option specifies the use of either the "large" (6 feet in height) or "small" (4 feet in height) human body mathematical model. The third parameter provides the user the capability to specify a graphics output filename (assuming this option has been toggled ON using the program logic/comment menu). If the user executes the option without changing the filename and a file already exists with the same filename, the user is notified and required to change the filename. Three of the last four menu variables define the locations that are to be analyzed using the option. These variables, all in units of feet, are the initial station position for analysis, the increment in station position, and the final

DISK VORTEX VELOCITY PROFILE DATA

```

X-LOCATION (XT)      =      150.00  FT
Y-LOCATION (YT)      =           .00  FT

VORTEX CIRCULATION  =      5441.24  FT**2/SEC
VORTEX CIRCULATION  =      505.51  M**2/SEC
5-M INITIAL CIRCULATION =      232.37  M**2/SEC
SETTLING ANGLE      =           9.29  DEG
    
```

PRESS <RETURN> TO CONTINUE

FIGURE D-23 DISK EDGE VORTEX OPTION INTERMEDIATE OUTPUT

HEIGHT		MEAN VELOCITY		MEAN Q
(FT)		(FPS)	(KN)	(PSF)
.00	X	-4.052	-2.402	.020
	Y	.000	.000	.000
	Z	.000	.000	.000
	T	4.052	2.402	.020
50.00	X	-6.444	-3.820	.049
	Y	.000	.000	.000
	Z	-27.295	-16.180	.885
	T	28.046	16.625	.935
100.00	X	-5.735	-3.399	.039
	Y	.000	.000	.000
	Z	-30.049	-17.812	1.073
	T	30.592	18.134	1.112

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-24 VELOCITY FIELD OUTPUT DATA FROM THE DISK EDGE VORTEX OPTION

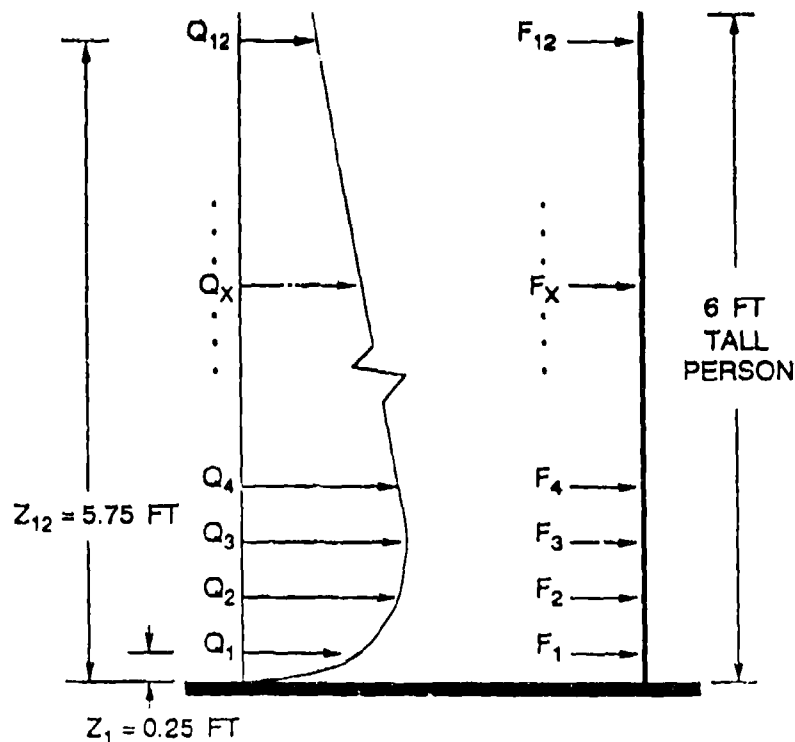


FIGURE D-25 OVERTURNING FORCE AND MOMENT CALCULATION PROCEDURES

station position, respectively. The fourth parameter is the user option to specify a minimum boundary layer height (discussed in section D.1.4 of the user's guide). The mechanics for input of the desired values using this menu are as described for previous menus.

After the analysis is executed by typing the **<RETURN>** key, the calculated results are written out in the format presented in figure D-27. Three columns of data are written using this format. The first column identifies either the distance from rotor center (DFRC) for the wall jet option or the distance along the interaction plane (DAIP) for the interaction plane option.

The second and third columns are the associated total force and total moment values calculated for the projected area of a human body. Example data for the XV-15 using this option are presented in figure D-28 for reference. At the bottom of the screen, the user is required to return to the previous menu by typing **<P>**,

OVERTURNING FORCE/MOMENT DATA MENU			
CODE	PARAMETER	VALUE	UNITS
A	<W>ALL JET OR <I>NTERACTION PLANE	W	
B	<L>ARGE OR <S>MALL PERSON	L	
C	DATA OUTPUT FILENAME	OTDFRC.PTS	
D	INITIAL STATION POSITION	30.00	FT
E	HORIZONTAL INCREMENT	10.00	FT
F	MAXIMUM STATION POSITION	100.00	FT
G	MINIMUM BOUNDARY LAYER HEIGHT	1.50	FT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

FIGURE D-26 OVERTURNING FORCE AND MOMENT DATA MENU

SUMMARY OF OVERTURNING FORCES AND MOMENTS			
	RADIUS (FT)	TOTF (LB)	TOTM (FT-LB)
	50.00	42.721	114.596
	60.00	33.708	91.718
	70.00	25.046	69.346
	80.00	17.520	49.892
	90.00	11.511	33.382
	100.00	6.926	20.269

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-27 SIMPLIFIED OUTPUT FORMAT FOR THE OVERTURNING FORCE AND MOMENT ANALYSIS

the master input data menu by typing <N>, or to exit the program by typing <X>. By typing <C>, the user can view the next video screen of data if more than one screen of data is generated. Otherwise, the <C> option works identically to the <P> option.

The user can examine the detailed calculations used to create the summary output by specifying the desired analysis location as the initial station position. This input must then be followed by specification of the increment value as 0.0 or only the summary output will appear (as shown in figure D-29). The resulting "large" person output using this option is presented on two screen frames as shown in figure D-30. The first output frame presents a summary of the velocity profile calculations as a function of height above ground at the specified station position. The second output frame presents the associated calculations for dynamic pressure, overturning force, and overturning moment. The last two columns in the second table are values of total force and moment summed for the incremental increase in height.

In this example, the force and moment values of 42.7 pounds and 114.6 foot-pounds, respectively, at 5.75 feet are the total force and moment values that would normally be printed out in the summary output (figure D-27). These values are checked by totaling the individual height-related values in the overturning force and moment columns (second and third columns). An example output for the second screen of the "small" person option is presented in figure D-31 for reference.

Both qualitative and quantitative overturning force and moment data are presented in section 5 of volume I of this report correlated with ROTWASH program output for the Bell XV-15, Sikorsky CH-53E, and the Sikorsky S-61. These calculated data all assume a coefficient of drag for a human body of 1.1 (which according to Hoerner, reference D-6, can vary from 1.0 to approximately 1.3).

D.1.9 PARTICULATE CLOUD ANALYSIS OPTION

The methodology used in the calculation of particulate cloud size is presented in section 5.8 of volume I of this report along with a very limited amount of flight test data. This option is applicable to both single main rotor and twin-rotor configurations. The particulate cloud geometry utilized in the analysis option is presented in figure D-32.

The particulate cloud option is initiated with the typing of <C> on the hazard analysis option menu as shown in figure D-6. The screen that is written subsequently presents the user with a prompt for input of the terrain erosion factor. The value for this factor is chosen from the graph in figure D-33.

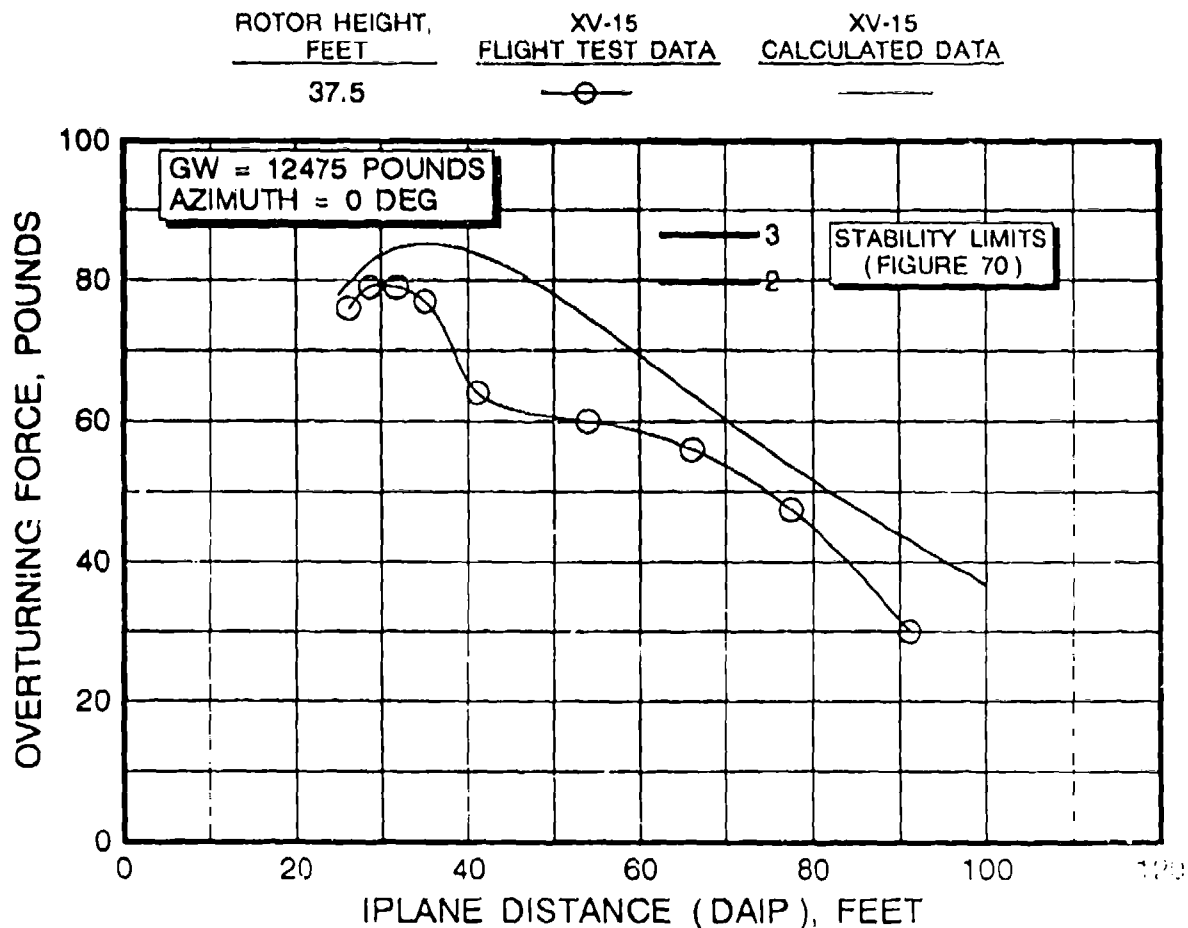


FIGURE D-28 BELL XV-15 OVERTURNING FORCE AS A FUNCTION OF DISTANCE ALONG THE INTERACTION PLANE (0 DEGREE AZIMUTH)

OVERTURNING FORCE/MOMENT DATA MENU

CODE	PARAMETER	VALUE	UNITS
A	<W>ALL JET OR <I>NTERACTION PLANE	W	
B	<L>ARGE OR <S>MALL PERSON	L	
C	DATA OUTPUT FILENAME	OTDFRC.PTS	
D	INITIAL STATION POSITION	50.00	FT
E	HORIZONTAL INCREMENT	.00	FT
F	MAXIMUM STATION POSITION	100.00	FT
G	MINIMUM BOUNDARY LAYER HEIGHT	1.50	FT

ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==>

FIGURE D-29 MENU SPECIFICATION OF DETAILED FORCE/MOMENT OUTPUT

SINGLE ROTOR VELOCITY PROFILE AT RADIUS = 50.0 FT

HEIGHT (FT)	MEAN VELOCITY (FPS) (KN)		PEAK VELOCITY (FPS) (KN)		MEAN Q (PSF)	PEAK Q (PSF)
.25	34.705	20.572	64.762	38.389	1.431	4.984
.75	40.602	24.068	75.767	44.912	1.959	6.822
1.25	43.676	25.890	81.502	48.312	2.267	7.894
1.75	42.515	25.202	82.535	48.924	2.148	8.096
2.25	38.121	22.597	79.742	47.269	1.727	7.557
2.75	34.004	20.157	75.248	45.197	1.374	6.909
3.25	30.146	17.870	72.134	42.759	1.080	6.184
3.75	26.537	15.730	67.491	40.007	.837	5.413
4.25	23.170	13.734	63.591	37.695	.638	4.806
4.75	20.041	11.880	61.475	36.441	.477	4.491
5.25	17.147	10.164	58.134	34.460	.349	4.016
5.75	14.485	8.586	53.785	31.882	.249	3.438

TYPE <RETURN> TO CONTINUE

SINGLE ROTOR FORCE PROFILE AT RADIUS = 50.0 FT

HEIGHT (FT)	PEAK Q (PSF)	FOVER (LB)	OVERM (FT-LB)	TOT F (LB)	TOT M (FT-LB)
.25	4.984	3.016	.754	3.016	.754
.75	6.822	4.128	3.096	7.143	3.850
1.25	7.894	4.776	5.970	11.919	9.820
1.75	8.096	4.898	8.571	16.817	18.391
2.25	7.557	4.572	10.287	21.389	28.678
2.75	6.909	4.180	11.495	25.569	40.174
3.25	6.184	3.741	12.159	29.311	52.333
3.75	5.413	3.275	12.282	32.586	64.615
4.25	4.806	2.908	12.357	35.493	76.972
4.75	4.491	2.717	12.907	38.211	89.879
5.25	4.016	2.430	12.757	40.641	102.636
5.75	3.438	2.080	11.960	42.721	114.596

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-30 DETAILED OUTPUT FORMAT FOR THE "LARGE" PERSON ANALYSIS OPTION

SINGLE ROTOR FORCE PROFILE AT RADIUS = 50.0 FT					
HEIGHT (FT)	PEAK Q (PSF)	FOVER (LB)	OVERM (FT-LB)	TOT F (LB)	TOT M (FT-LB)
.25	4.984	1.919	.480	1.919	.480
.75	6.822	2.627	1.970	4.546	2.450
1.25	7.894	3.039	3.799	7.585	6.249
1.75	8.096	3.117	5.455	10.702	11.703
2.25	7.557	2.909	6.546	13.611	18.250
2.75	6.909	2.660	7.315	16.271	25.565
3.25	6.184	2.381	7.738	18.652	33.303
3.75	5.413	2.084	7.816	20.736	41.118

TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==>

FIGURE D-31 DETAILED OUTPUT FORMAT FOR THE SECOND SCREEN FRAME OF THE "SMALL" PERSON ANALYSIS OPTION

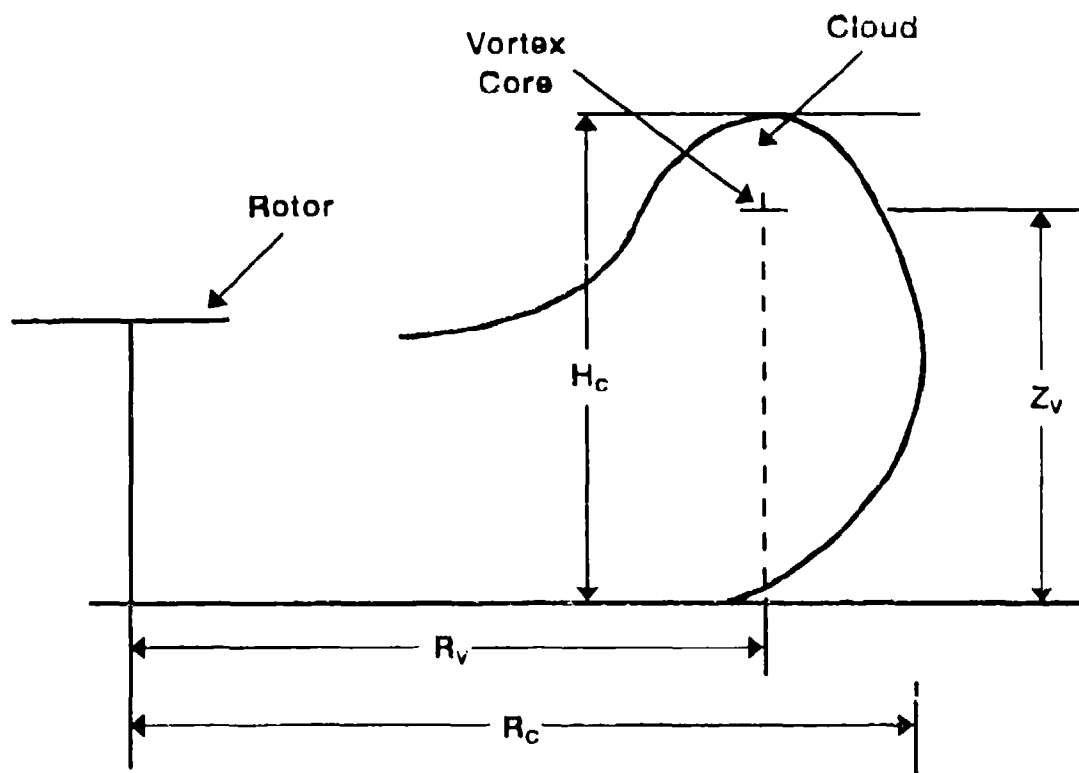
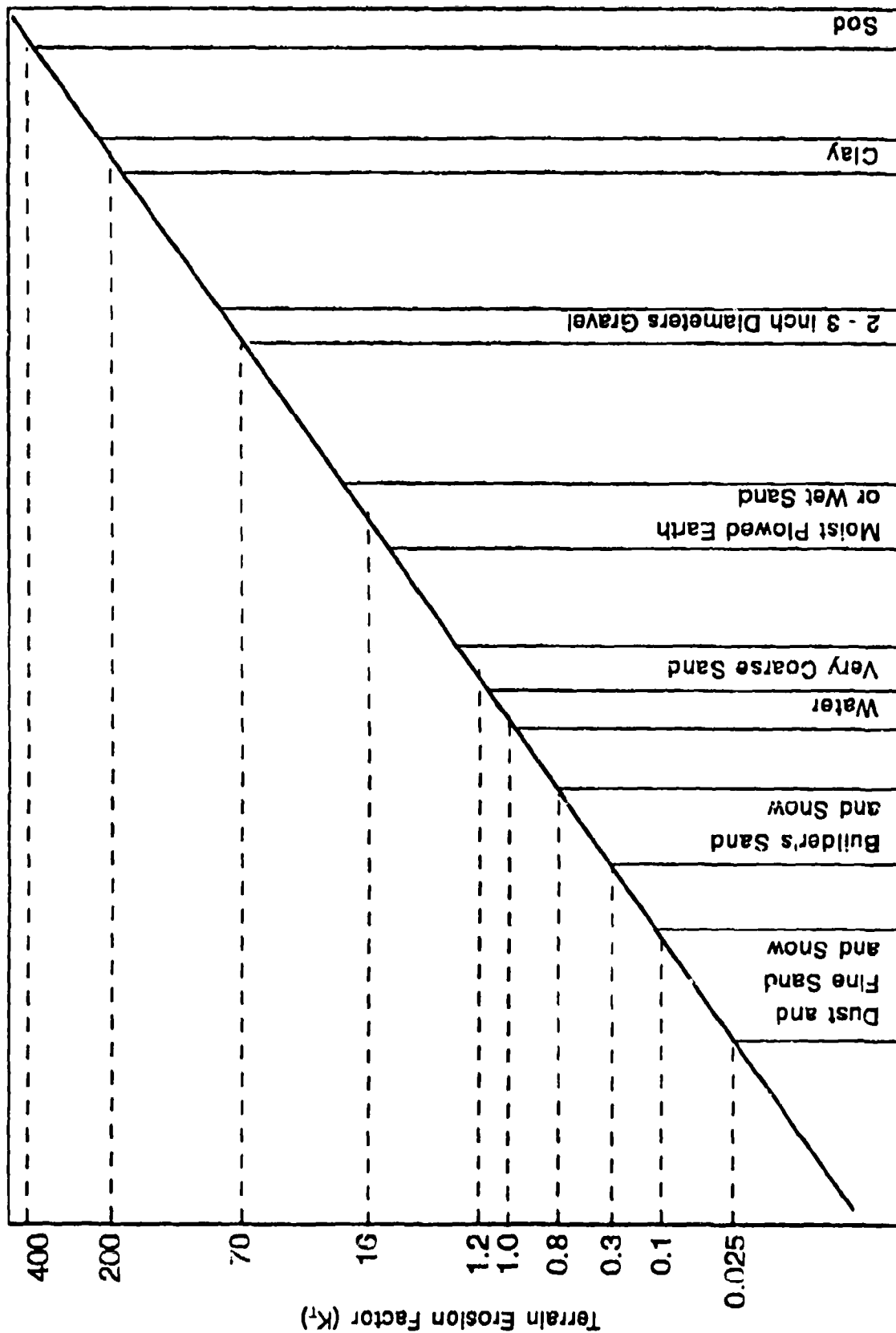


FIGURE D-32 PARTICULATE CLOUD ANALYSIS GEOMETRY DEFINITION



General Terrain Type

FIGURE D-33 APPROXIMATE VALUES FOR THE TERRAIN EROSION FACTOR (K_t) AS IDENTIFIED IN THE LITERATURE

The output format for the particulate cloud option is designed for both single main rotor and twin-rotor aircraft as shown in figure D-34. In this example, using the XV-15, the particulate cloud boundaries located at the 90- and 270-degree azimuths (out the span of the wing) are specified by the single rotor or "SR" row of output values. The interaction plane or "IP" row defines the cloud boundaries which exist straight out in front of and directly aft of the aircraft along the aircraft centerline. If a single main rotor configuration is being evaluated, the "IP" row in the printout will contain all zeros.

ENTER TERRAIN EROSION FACTOR (-ND-) ==> 0.4				
SUMMARY OF CLOUD BOUNDARIES				
RC AND RV ARE FROM ROTOR CENTER (FT)				
	RC	RV	ZV	HC
SR	80.1	62.8	26.3	37.6
IP	113.0	88.7	37.2	53.0
QSMAX = 13.5 PSF				
TYPE <C>ONTINUE, NEXT <P>OINT, <N>EW CASE, E<X>IT ==				

FIGURE D-34 PARTICULATE CLOUD ANALYSIS OPTION OUTPUT

D.2 ROTWASH PROGRAM DATA OUTPUT FILE FORMATS

Four data output file formats can be specified from the ROTWASH program for use with computer graphics programs. Two of these output file formats are generated by the wall jet and interaction plane velocity profile analysis options. The other two formats are generated by the personnel overturning force and moment option. These file formats save the summary force and moment data for both the wall jet and interaction plane cases.

The first two lines in each of the four file formats are user-specified comments. These two comment lines are typed in through use of the program logic/comment menu. The rest of the data in each of the file formats is either header information or engineering data. The example files presented in this section are written for direct input to the TECPLOT Graphics Program which is written by AMTEC Engineering. This graphics program is one of several IBM PC/PC-compatible engineering graphics programs

presently on the market. Users that do not have access to this program can easily modify the ROTWASH FORTRAN code for other types of graphics programs by modifying the appropriate write statements. Table 1 provides the user with a cross reference of the figure number for each of the four output types and the source location for the associated FORTRAN code that can be modified (see program listings in appendix E).

TABLE D-1 GRAPHICS FILE/SOURCE CODE REFERENCE MATRIX

FILE OUTPUT TYPE	FIGURE	SOURCE CODE LOCATION
Wall Jet Velocity Profile Output	D-35	Subroutine WJVEL
Interaction Plan Velocity Profile Output	D-36	Subroutine IPVEL
Overturning Force/Moment Summary (Wall Jet)	D-37	Subroutine HWJVEL
Overturning Force/Moment Summary (Interaction Plan)	D-38	Subroutine HIPVEL

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="VELOCITY PROFILE, DPRC = 50.0 FT, GW = 13000 LB, WAGL = 25.0 FT"
VARIABLES = X,HT

ZONE T = "MEAN PROFILE, KTS", I=11, F=POINT

.0	.00
25.1	1.00
23.9	2.00
19.0	3.00
14.7	4.00
11.0	5.00
7.8	6.00
5.2	7.00
3.2	8.00
1.6	9.00
.6	10.00

ZONE T = "PEAK PROFILE, KTS", I=11, F=POINT

.0	.00
46.8	1.00
48.2	2.00
44.0	3.00
38.5	4.00
35.5	5.00
30.4	6.00
23.7	7.00
16.3	8.00
9.3	9.00
3.7	10.00

ZONE T = "PEAK Q, PSF", I=11, F=POINT

.0	.00
7.4	1.00
7.8	2.00
6.6	3.00
5.0	4.00
4.3	5.00
3.1	6.00
1.9	7.00
.9	8.00
.3	9.00
.0	10.00

FIGURE D-35 EXAMPLE WALL JET OPTION GRAPHICS FILE FORMAT

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="VELOCITY PROFILE, DAIP = 50.0 FT, GW = 13000 LB, WAGL = 25.0 FT"
VARIABLES = X,HT

ZONE T = "MEAN PROFILE, KTS", I=11, F=POINT

.0	.00
37.7	1.00
39.5	2.00
39.0	3.00
38.5	4.00
37.9	5.00
37.4	6.00
36.8	7.00
36.3	8.00
35.7	9.00
35.1	10.00

ZONE T = "PEAK PROFILE, KTS", I=11, F=POINT

.0	.00
61.6	1.00
64.6	2.00
63.7	3.00
62.9	4.00
62.0	5.00
61.1	6.00
60.2	7.00
59.3	8.00
58.3	9.00
57.4	10.00

ZONE T = "PEAK Q, PSF", I=11, F=POINT

.0	.00
12.9	1.00
14.1	2.00
13.7	3.00
13.4	4.00
13.0	5.00
12.6	6.00
12.3	7.00
11.9	8.00
11.5	9.00
11.1	10.00

FIGURE D-36 EXAMPLE INTERACTION PLANE OPTION GRAPHICS FILE FORMAT

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="SINGLE ROTOR DFRC DATA"

VARIABLES = DFRC,TOTF,TOTM

ZONE T = "GW = 13000 LB, WAGL = 25.0 FT", I=6, F=POINT

50.00	42.72	114.60
60.00	33.71	91.72
70.00	25.05	69.35
80.00	17.52	49.89
90.00	11.51	33.38
100.00	6.93	20.27

FIGURE D-37 EXAMPLE PERSONNEL OVERTURNING FORCE AND MOMENT GRAPHICS FILE FORMAT CREATED WITH THE WALL JET ANALYSIS OPTION

XV-15 CHARACTERISTICS ARE USED AS INPUT DATA
GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS

TITLE="TWIN ROTOR DAIP DATA"

VARIABLES = DAIP,TOTF,TOTM

ZONE T = "GW = 13000 LB, WAGL = 25.0 FT", I=6, F=POINT

50.00	94.05	288.66
60.00	83.94	259.37
70.00	73.00	227.47
80.00	62.43	196.32
90.00	52.82	167.46
100.00	44.26	141.31

FIGURE D-38 EXAMPLE PERSONNEL OVERTURNING FORCE
AND MOMENT GRAPHICS FILE FORMAT CREATED
WITH THE INTERACTION PLANE ANALYSIS OPTION

LIST OF REFERENCES

- D-1. Ferguson, S.W., and J.D. Kocurek, "Analysis and Recommendation of Separation Requirements for Rotorcraft Operation at Airports and Heliports," Systems Technology, Inc, Report TR-1224-1, September 1986.
- D-2. Ferguson S.W., "Evaluation of Rotorwash Characteristics for Tiltrotor and Tiltwing Aircraft in Hovering Flight," U.S. Department of Transportation, Federal Aviation Administration, DOT/FAA/RD-90/16, December 1990.
- D-3. Harris, D.J., and R.D. Simpson, "Technical Evaluation of the Rotor Downwash Flow Field of the XV-15 Tilt Rotor Research Aircraft," Naval Air Test Center, Technical Report No. SY-14R-83, July 1983.
- D-4. Harris, D.J., and R.D. Simpson, "CH-53E Helicopter Downwash Evaluation. Final Report," Naval Air Test Center, Technical Report No. SY-89R-78, August 1978.
- D-5. Harris, D.J., and R.D. Simpson, "CL-84 Tilt-Wing Vertical and Short Takeoff and Landing Downwash Evaluation. Final Report," Naval Air Test Center, Technical Report No. SY-52R-76, April 1976.
- D-6. Hoerner, S.F., Fluid-Dynamic Drag, Published by Author, 1958.

APPENDIX E ROTWASH PROGRAM FORTRAN 77 LISTINGS

ROTWASH program listings are presented in this appendix for the ROTWASH main program and its 24 subroutines. The listings are for a version of the program that is run on IBM PC/PC-compatible computers using MICROSOFT FORTRAN 77, Version 5.0. The tabular listing below indexes subroutine names and briefly describes functionality for user reference.

<u>SUBROUTINE</u>	<u>FUNCTION</u>
ROTWASH	Main Program Driver and Initialization
CLOUD	Calculates Particle Cloud Boundaries
DFVTX	Locates Disk Edge Vortex System and Calculates Induced Velocity Field
FREAD	Prompt/Validate for Floating Point Input Data
GDVTX	Locates Ground Vortex System and Calculates Induced Velocity Field
HAZARD	Driver Subroutine for Hazard Analysis
HIPVEL	Twin Rotor Overturning Forces and Moments
HOMCLS	Home Cursor and Clear Screen
HSVTX	Calculates Induced Velocity Field of a Horseshoe Vortex System
HWJVEL	Single Rotor Overturning Forces and Moments
INKEY	Menu Input Data Control
INPUT	Rotorcraft Characteristics Input Data Menu
INPUTV	Velocity Profile Status Menu
INPUTX	Ground/Disk Vortex Input Data Menu
IOFNSH	Close Disk I/O Files
IOINIT	File I/O Management Menu
IPVEL	Calculates Interaction Plane Velocity Profile
IREAD	Prompt/Validate for Integer Input Data
LEGAL	Check Validity of Input Data Selection Codes
LOCATE	Locate Cursor Position
MOMENT	Calculates Personnel Overturning Forces and Moments
PROPRM	Calculates Radial Wall Jet Velocity Profile
VLIN	Calculates Induced Velocity from a Line Vortex Field
WALJET	Defines Initial Wall Jet Position and Growth Parameters
WJVEL	Calculates Single Rotor Velocity Profile

PROGRAM ROTWASH

```

1  C
2  C
3  PROGRAM ROTWASH
4  C
5  C *****
6  C ROTORCRAFT DOWNWASH HAZARD ANALYSIS PROGRAM
7  C
8  C EMA
9  C SAMUEL W. FERGUSON
10 C
11 C 1 APRIL 1993
12 C
13 C PROGRAM VERSION 2.1
14 C
15 C THIS PROGRAM WAS DEVELOPED USING MICROSOFT FORTRAN 77 FOR
16 C THE DOS OPERATING SYSTEM.  CONSOLE DISPLAY CONTROL IS
17 C PROVIDED WITH THIS PROGRAM IN SEVERAL SPECIAL SUBROUTINES.
18 C *****
19 C
20 C PARAMETER(NUM = 10)
21 C
22 C CHARACTER*1 OKLIST(NUM)
23 C CHARACTER*1 KEY,KKEY,FLOW,VELHAZ,HAZTYP
24 C CHARACTER*1 ICONT(5)
25 C CHARACTER*1 TEMCHAR
26 C CHARACTER*12 PTSFIL(4)
27 C CHARACTER*50 COMM(2)
28 C REAL*4 KE
29 C
30 C DIMENSION CONT(9),CONTV(7),CONTX(8)
31 C
32 C COMMON / CKEY/ KEY,KKEY
33 C COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
34 C COMMON /HELGEO/ H,DL,YSEP,WSPD,RADIUS,SHFTAN,DXO
35 C COMMON /INPUTC/ ICONT,COMM,PTSFIL
36 C COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
37 C COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
38 C COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
39 C
40 C DATA CONT/2.0,32.2,12.5,12475.0,13.0,37.5,0.0,1.0,0.0/
41 CH53E DATA CONT/1.0,0.0,39.5,56000.0,5.0,600.0,0.0,0.975,0.0/
42 C DATA YBDLAY/1.5/
43 C DATA ICONT/'V','N','N','W','L'/
44 C DATA CONTV/59.3,1.0,10.0,50.0,10.0,100.0,0.0/
45 C DATA CONTX/733.0,7.0,50.0,200.0,0.0,20.0,100.0,0.0/
46 C DATA PTSFIL/'DFRC.PTS','DAIP.PTS','OTDFRC.PTS','OTDAIP.PTS'/
47 C DATA COMM/
48 C 1 'XV-15 CHARACTERISTICS ARE USED AS INPUT DATA ',
49 C 2 'GROSS WEIGHT MIGHT BE ONE OF THE COMMENT STRINGS ' /
50 C
51 C DATA OKLIST /'W','w','I','i','G','g','D','d','X','x'/
52 C
53 C *****
54 C
55 C -----
56 C INITIALIZE I/O SYSTEM
57 C -----
58 C
59 C CALL IOINIT
60 C
61 C -----
62 C INITIALIZE MISCELLANEOUS CONSTANTS
63 C -----

```

PROGRAM ROTWASH

```

64 C
65     PI      = ACOS(-1.0)
66     RHOSL   = 0.0023769
67     FPSPKN  = 1.687
68     DRC     = 0.01745329252
69 C
70     50 CONTINUE
71 C
72     KEY = ' '
73     KKEY = ' '
74 C
75 C -----
76 C OBTAIN INPUT DATA PARAMETERS FROM STATUS SCREEN
77 C -----
78 C
79     CALL INPUT
80 C
81 C -----
82 C DEFINE PARAMETERS OBTAINED FROM SUBROUTINE INPUT
83 C -----
84 C
85     ROTORS = CONT(1)
86     YYSEP  = CONT(2)
87     RADIUS = CONT(3)
88     HELGW  = CONT(4)
89     DWNLD  = CONT(5)
90     HAGL   = CONT(6)
91     SHFTAN = CONT(7)
92     SIGPR  = CONT(8)
93     WSPD   = CONT(9)
94 C
95     VELHAZ = ICONT(1)
96 C
97 C -----
98 C ADJUST GEOMETRY IF SHAFT ANGLE > 0.0 DEGREES
99 C -----
100 C
101     RSHFT  = SHFTAN*DRC
102     CSHFTA = COS(RSHFT)
103     DXO    = HAGL*TAN(RSHFT)
104 C
105 C -----
106 C NON-DIMENSIONALIZE SOME OF THE INPUT PARAMETERS
107 C -----
108 C
109     H      = HAGL/RADIUS/CSHFTA
110     YSEP   = YYSEP/2.0/RADIUS
111     EFFGW  = HELGW*(1.0 + (DWNLD/100.0))
112     DL     = EFFGW/ROTORS/PI/RADIUS**2
113     RHO    = SIGPR*RHOSL
114     RHOD2  = 0.5*RHO
115 C
116 C -----
117 C SWITCHING CALLS HAZARD PROGRAM AND ALLOWS RETURN (IF DESIRED)
118 C TO THE MAINLINE ROUTINE TO CHANGE ROTORCRAFT INPUT PARAMETERS
119 C -----
120 C
121     IF(VELHAZ.EQ.'H') THEN
122 C
123         KKEY = 'H'
124         CALL HAZARD(HAZTYP)
125 C
126         IF(KEY.EQ.'X') GOTO 999

```

PROGRAM ROTWASH

```

127      IF (FLOW.EQ.'X') GOTO 999
128      IF (HAZTYP.EQ.'X') GOTO 999
129      GOTO 50
130  C
131      ELSE
132  C
133      KKEY = 'V'
134  C
135      END IF
136  C
137  C -----
138  C SELECT FLOWFIELD OPTION
139  C -----
140  C
141      10 CONTINUE
142  C
143  C -----
144  C HOME CURSOR AND CLEAR SCREEN
145  C -----
146  C
147      ICD = 0
148      CALL HOMCLS(ICD)
149      CALL LOCATE(3,1)
150  C
151      WRITE(IOU1,11)
152      11 FORMAT ( 20X,' SELECT TYPE OF FLOW TO BE ESTIMATED',///,
153      1          20X,'WALL JET PROFILE,          TYPE <W>',/,
154      2          20X,'INTERACTION PLANE PROFILE, TYPE <I>',/,
155      2          20X,'GROUND VORTEX,             TYPE <G>',/,
156      2          20X,'DISK VORTEX,               TYPE <D>',/,
157      3          20X,'TO EXIT PROGRAM,           TYPE <X>',//)
158  C
159  C -----
160  C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT
161  C -----
162  C
163      40 CONTINUE
164  C
165      WRITE(IOU1,' (23X,A,$)')
166      1 ' ENTER DATA ENTRY CODE ==> '
167  C
168      READ(IOU1,' (A1)') FLOW
169  C
170      IF (LEGAL(FLOW,IOU1,OKLIST,NUM).EQ.1) GOTO 40
171  C
172  C -----
173  C MAKE LEGAL LOWERCASE INPUTS UPPER CASE BEFORE BRANCHING
174  C -----
175  C
176      IF (FLOW.EQ.'w') FLOW = 'W'
177      IF (FLOW.EQ.'i') FLOW = 'I'
178      IF (FLOW.EQ.'g') FLOW = 'G'
179      IF (FLOW.EQ.'d') FLOW = 'D'
180      IF (FLOW.EQ.'x') FLOW = 'X'
181  C
182  C -----
183  C HOME CURSOR AND CLEAR SCREEN
184  C -----
185  C
186      ICD = 0
187      CALL HOMCLS(ICD)
188  C
189  C -----

```

PROGRAM ROTWASH

```

190 C   BRANCH BASED ON CHOSEN OPTION, ALSO
191 C   CHECK NUMBER OF ROTORS TO LIMIT SOME OPTIONS
192 C   -----
193 C
194 C   IF (FLOW.EQ.'X') GOTO 999
195 C   IF (FLOW.EQ.'W') GOTO 12
196 C
197 C   IF (FLOW.EQ.'I') THEN
198 C       IF (ROTORS.GT.1.0) GOTO 12
199 C       WRITE(IOU1,'(////,14X,A,$)')
200 C   1 ' REQUIRES TWO ROTORS, TYPE <RETURN> TO CONTINUE '
201 C       READ(IOU1,'(A1)') TEMCHAR
202 C       GOTO 10
203 C   ENDIF
204 C
205 C   IF (FLOW.EQ.'G') THEN
206 C       IF (ROTORS.LT.2.0) GOTO 1000
207 C       WRITE(IOU1,'(////,14X,A,$)')
208 C   1 ' REQUIRES ONE ROTOR, TYPE <RETURN> TO CONTINUE '
209 C       READ(IOU1,'(A1)') TEMCHAR
210 C       GOTO 10
211 C   ENDIF
212 C
213 C   IF (FLOW.EQ.'D') THEN
214 C       IF (ROTORS.LT.2.0) GOTO 1000
215 C       WRITE(IOU1,'(////,14X,A,$)')
216 C   1 ' REQUIRES ONE ROTOR, TYPE <RETURN> TO CONTINUE '
217 C       READ(IOU1,'(A1)') TEMCHAR
218 C       GOTO 10
219 C   ENDIF
220 C
221 C   GOTO 10
222 C
223 C   12 CONTINUE
224 C
225 C   *****
226 C   RADIAL WALL JET FLOWS
227 C   *****
228 C
229 C   -----
230 C   ACCELERATED SLIPSTREAM MEAN VELOCITY
231 C   -----
232 C
233 C   UN = SQRT(2.0*DL/RHO)
234 C
235 C   -----
236 C   GROUND EFFECT CORRECTION
237 C   -----
238 C
239 C   AKG = 1.0 - 0.9*EXP(-2.0*H)
240 C
241 C   -----
242 C   MEAN VELOCITY AT ROTOR DISK (RATIOED TO UN)
243 C   -----
244 C
245 C   UB = AKG/2.0
246 C
247 C   -----
248 C   FIND INITIAL RADIUS OF WALL JET
249 C   -----
250 C
251 C   CALL WALJET(H,UB,UN,UMB)
252 C

```


PROGRAM ROTWASH

```

253     500 CONTINUE
254     C
255         IF(KEY.EQ.'X')GOTO 999
256         IF(KEY.EQ.'N')GOTO 50
257         IF(FLOW.EQ.'I')GOTO 700
258     C
259     600 CONTINUE
260     C
261     C -----
262     C WALL JET REGION
263     C
264     C OBTAIN INPUT DATA FOR THE WALL JET OPTION
265     C -----
266     C
267     CALL INPUTV(FLOW)
268     C
269     RVZ    = (CONTV(1) - DXO)/RADIUS
270     DELZ   = CONTV(2)/RADIUS
271     ZMAX   = CONTV(3)/RADIUS
272     BDLAYM = YBDLAY/RADIUS
273     C
274     C -----
275     C GENERATE VELOCITY PROFILE AT RVZ IN WALL JET REGION
276     C -----
277     C
278     CALL WJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELZ,ZMAX,DXO,BDLAYM)
279     C
280     GOTO 500
281     C
282     700 CONTINUE
283     C
284     C -----
285     C INTERACTION PLANE UPWASH DEFLECTION ZONE
286     C
287     C OBTAIN INPUT DATA FOR THE IPLANE OPTION
288     C -----
289     C
290     CALL INPUTV(FLOW)
291     C
292     XIP    = (CONTV(1) - DXO)/RADIUS
293     DELZ   = CONTV(2)/RADIUS
294     ZMAX   = CONTV(3)/RADIUS
295     BDLAYM = YBDLAY/RADIUS
296     C
297     C -----
298     C GENERATE VELOCITY PROFILE AT XIP IN INTERACTION PLANE
299     C -----
300     C
301     CALL IPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELZ,ZMAX,DXO,BDLAYM)
302     C
303     GOTO 500
304     C
305     1100 CONTINUE
306     C
307         IF(KEY.EQ.'X')GOTO 999
308         IF(KEY.EQ.'N')GOTO 50
309     C
310     1000 CONTINUE
311     C
312     C *****
313     C HORSESHOE VORTEX FLOWS
314     C *****
315     C

```

PROGRAM ROTWASH

```

316 C -----
317 C OBTAIN INPUT DATA FOR VORTEX OPTIONS
318 C -----
319 C
320 CALL INPUTX
321 C
322 OMEGAR = CONTX(1)
323 B      = CONTX(2)
324 VF     = CONTX(3)
325 XT     = CONTX(4)/RADIUS
326 YT     = CONTX(5)/RADIUS
327 DELZ   = CONTX(6)/RADIUS
328 ZMAX   = CONTX(7)/RADIUS
329 C
330 VF = VF*FPSPKN
331 AMU = VF/OMEGAR
332 CT = DL/RHO/OMEGAR**2
333 C
334 C -----
335 C ITERATE TO GET INFLOW RATIO
336 C -----
337 C
338 ALOLD = SQRT(CT/2.0)
339 C
340 DO 1300 ITER=1,100
341 C
342 ALNEW = CT/2.0/SQRT(ALOLD**2 + AMU**2)
343 C
344 IF (ABS(ALNEW - ALOLD).LE.1.0E-05)GOTO 1301
345 C
346 ALOLD = ALNEW
347 C
348 1300 CONTINUE
349 C
350 C -----
351 C HOME CURSOR AND CLEAR SCREEN
352 C -----
353 C
354 ICD = 0
355 CALL HOMCLS(ICD)
356 CALL LOCATE(5,1)
357 C
358 WRITE(10U1,20)
359 20 FORMAT('*****',/
360 1      , 'ITERATIONS EXCEEDED FOR INFLOW RATIO',/
361 2      , '*****')
362 C
363 STOP ' '
364 C
365 1301 CONTINUE
366 C
367 ALAMDA = ALNEW
368 AMUS = AMU/SQRT(CT/2.0)
369 GAMT = OMEGAR*RADIUS*2.0*PI*CT/B
370 CHI = ATAN(ALAMDA/AMU)/2.0
371 C
372 C -----
373 C GAMWP IS FOR UNIFORM LOADING IN FORWARD FLIGHT.
374 C 0.625 FACTOR COMES FROM UNPUBLISHED FAA FLIGHT TEST DATA.
375 C IF SETTLING ANGLE CHI <= 8.0 DEGREES, THEN USE GAMWP AS IS.
376 C IF > 8.0 DEGREES, THEN REDUCE GAMWP BY THE LINEAR
377 C RATE OF 6.5% PER DEGREE OF SETTLING ANGLE. THE REDUCTION
378 C IS A SIMPLE APPROXIMATION FOR THE NEAR TERM THAT IS BASED

```

PROGRAM ROTWASH

```

379 C   ON AN ANALYSIS OF THE UNPUBLISHED FAA FLIGHT TEST DATA.
380 C   MODS MADE FEBRUARY 1993.
381 C   -----
382 C
383     KE      = 0.625
384     GAMWP   = PI*RADIUS*OMEGAR**2*CT/VF/2.0/KE
385 C
386     IF(CHI.LE.0.139616) THEN
387         GAMW = GAMWP
388     ELSE
389         GAMW = GAMWP*(1.0 - (CHI - 0.139616)*0.065*57.3)
390         IF(GAMW.LT.0.0) GAMW = 0.0
391     ENDIF
392 C
393     HOD = H/2.0
394 C
395 C   -----
396 C   HOME CURSOR AND CLEAR SCREEN
397 C   -----
398 C
399     ICD = 0
400     CALL HOMCLS(ICD)
401     CALL LOCATE(3,1)
402 C
403     IF(FLOW.EQ.'D') GOTO 1200
404 C
405 C   -----
406 C   GROUND VORTEX
407 C   -----
408 C
409     WRITE(IOU1,1001) HOD,AMUS,AMU
410 1001 FORMAT( 18X,'ROTOR HEIGHT ABOVE GROUND H/D',2X,F8.4,/
411           1      ,18X,'ADVANCE RATIO MU-STAR',2X,F8.4,/
412           2      ,18X,'ADVANCE RATIO MU',2X,F8.4,/)
413 C
414 C   -----
415 C   THE VALUE INPUT HERE REQUIRES USE OF THE CHART IN FIGURE 18
416 C   OF THE ACCOMPANYING DOCUMENTATION FOR THE GROUND VORTEX
417 C   -----
418 C
419 30 CONTINUE
420 C
421     WRITE(IOU1,31)
422 31 FORMAT( 18X,'ENTER GROUND VORTEX STRENGTH RATIO',/,
423           1      25X,'(SEE FIGURE 18) ==> '$)
424 C
425     READ(IOU1,*,ERR=30) GAMG
426 C
427     IF(GAMG.LT.0.0) GAMG = 0.0
428 C
429 C   -----
430 C   CONTINUE ANALYSIS
431 C   -----
432 C
433     GAMG = GAMG*GAMT
434 C
435     CALL GDVTX(H,RADIUS,AMU,CT,GAMG,XT,YT,DELZ,ZMAX)
436 C
437     GOTO 1100
438 C
439 1200 CONTINUE
440 C
441 C   -----

```

PROGRAM ROTWASH

```
442 C    DISK VORTEX
443 C    -----
444 C
445 C    CALL DEVTX(H,RADIUS,GAMW,CHI,XT,YT,DELZ,ZMAX)
446 C
447 C    GOTO 1100
448 C
449 C    -----
450 C    NORMAL PROGRAM EXIT
451 C    -----
452 C
453 C    999 CONTINUE
454 C
455 C    END
456 C
457
```

SUBROUTINE CLOUD

```

1  C
2  C
3  SUBROUTINE CLOUD (UN,UMB)
4  C
5  C *****
6  C SUBROUTINE CLOUD
7  C
8  C THIS SUBROUTINE MAKES THE CALCULATIONS REQUIRED IN ESTIMATING
9  C THE PARTICLE CLOUD BOUNDARIES ( NO DENSITIES ) FOR SINGLE AND
10 C TWIN ROTOR CONFIGURATIONS
11 C *****
12 C
13 CHARACTER*1 KEY,KKEY
14 CHARACTER*1 ICONT(5)
15 CHARACTER*12 PTSFIL(4)
16 CHARACTER*50 COMM(2)
17 C
18 COMMON / CKEY/ KEY,KKEY
19 COMMON /CLOUDK/ QSMAX
20 COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
21 COMMON /HELGEO/ H,DL,YSEP,WSPD,RADIUS,SHFTAN,DXO
22 COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
24 COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
25 C
26 C *****
27 C
28 C -----
29 C CLEAR SCREEN AND HOME CURSOR
30 C -----
31 C
32 ICD = 0
33 CALL HCMCLS(ICD)
34 CALL LOCATE(3,1)
35 C
36 C -----
37 C READ IN THE TERRAIN FACTOR CONSTANT
38 C (SEE FIGURE 30 OF USER'S GUIDE)
39 C -----
40 C
41 10 CONTINUE
42 C
43 WRITE(IOU1,20)
44 20 FORMAT( 15X,'ENTER TERRAIN EROSION FACTOR (-ND-) --> ', $)
45 C
46 READ(IOU1,*,ERR=10) XKT
47 C
48 C -----
49 C VALIDATE REAL INPUT VALUE
50 C -----
51 C
52 IF(XKT.LE.0.0.OR.XKT.GT.500.0)GOTO 10
53 C
54 C -----
55 C DEFINE CLOUD BOUNDARY CONSTANTS
56 C -----
57 C
58 XKT = SQRT(XKT)
59 C
60 QSMX = RHOD2*((SQRT(QSMAX)*UN)**2)
61 ERC = -0.437
62 XUM = (UMB*UN)**2
63 XCU = CU*CU

```

SUBROUTINE CLOUD

```

64      C1  = 1.0
65      C2  = 2.2
66      C
67      C
68      C-----
69      C SINGLE ROTOR CLOUD BOUNDARY CALCULATIONS
70      C-----
71      RCR = RADIUS*((XKT/(C1*RHOD2*XUM*XCU))**ERC)
72      RVR = 0.785*RCR
73      ZVR = 0.329*RCR
74      RCVR = RCR - RVR
75      AR  = (2.0/PI)*ALOG(ZVR/RCVR)
76      PHIR = (PI/2.0)*ALOG(RCVR)/ALOG(ZVR/RCVR)
77      AXLV = AR*((-PI/2.0) + PHIR)
78      XLV  = EXP(AXLV)
79      HCR  = XLV + ZVR
80      C
81      C-----
82      C INITIALIZE INTERACTION PLANE BOUNDARIES
83      C-----
84      C
85      RCI = 0.0
86      RVI = 0.0
87      ZVI = 0.0
88      HCI = 0.0
89      IF(YSEP.LE.0.1)GOTO 30
90      C
91      C-----
92      C INTERACTION PLANE CLOUD BOUNDARY CALCULATIONS
93      C-----
94      C
95      RCI = RADIUS*((XKT/(C2*RHOD2*XUM*XCU))**ERC)
96      RVI = 0.785*RCI
97      ZVI = 0.329*RCI
98      RCVR = RCI - RVI
99      AR  = (2.0/PI)*ALOG(ZVI/RCVR)
100     PHIR = (PI/2.0)*ALOG(RCVR)/ALOG(ZVI/RCVR)
101     AXLV = AR*((-PI/2.0) + PHIR)
102     XLV  = EXP(AXLV)
103     HCI  = XLV + ZVI
104     C
105     30 CONTINUE
106     C
107     C-----
108     C PRINTOUT OF BOUNDARY LIMITS
109     C-----
110     C
111     IF(IOU6.NE.IOU1) WRITE(IOU6,(' '1''))
112     C
113     C-----
114     C WRITE "40 FORMAT" IF OUTPUT TO GRAPHICS FILE
115     C-----
116     C
117     IF(IOU6.EQ.6) WRITE(IOU6,40) COMM(1),COMM(2)
118     40 FORMAT( 10X,A50/,10X,A50,/)
119     C
120     WRITE(IOU6,50)
121     50 FORMAT( //,
122     1      20X,' SUMMARY OF CLOUD BOUNDARIES',//,
123     2      20X,' RC AND RV ARE FROM ROTOR CENTER (FT)',//,
124     3      20X,' RC ',7X,' RV ',7X,' ZV ',7X,' HC ',/)
125     C
126     WRITE(IOU6,60) RCR,RVR,ZVR,HCR

```

SUBROUTINE CLOUD

```
127      60 FORMAT( 13X,'SR',F10.1,3F11.1)
128      C
129      WRITE(IOU6,70) RCI,RVI,ZVI,HCI
130      70 FORMAT( 13X,'IP',F10.1,3F11.1)
131      C
132      WRITE(IOU6,80) QSMX
133      80 FORMAT( /,12X,' QSMAX =',F7.1,' PSF',/)
134      C
135      C -----
136      C DECIDE NEXT OPTION WITH INKEY
137      C -----
138      C
139      CALL INKEY
140      C
141      RETURN
142      END
143      C
```

SUBROUTINE DEVTX

```

1  C
2  C
3  SUBROUTINE DEVTX(H,RADIUS,GAMW,CHI,XT,YT,DELZ,ZMAX)
4  C
5  C *****
6  C SUBROUTINE DEVTX
7  C
8  C THIS SUBROUTINE LOCATES THE DISK EDGE VORTEX SYSTEM, AND
9  C DIRECTS THE CALCULATION OF ITS INDUCED VELOCITY FIELD
10 C *****
11 C
12 CHARACTER*1 TEMCHAR
13 CHARACTER*1 KEY,KKEY
14 CHARACTER*1 ICONT(5)
15 CHARACTER*12 PTSFIL(4)
16 CHARACTER*50 COMM(2)
17 C
18 COMMON / CKEY/ KEY,KKEY
19 COMMON /CHSVTX/ XL1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
20 1 XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
21 COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
22 COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
24 C
25 C *****
26 C
27 C -----
28 C ASSUME HORSESHOE SHAPE - ASSIGN LEFT AND RIGHT CORNERS
29 C -----
30 C
31 XL1 = 0.0
32 YL1 = -1.0
33 ZL1 = H
34 C
35 XR1 = 0.0
36 YR1 = 1.0
37 ZR1 = H
38 C
39 C -----
40 C SET UP DIRECTION POINTERS FOR TRAILER ELEMENTS
41 C POINT 2 IS AT GROUND IMPINGEMENT
42 C -----
43 C
44 XL2 = XL1 + H/TAN(CHI)
45 YL2 = YL1
46 ZL2 = 0.0
47 C
48 XR2 = XR1 + H/TAN(CHI)
49 YR2 = YR1
50 ZR2 = 0.0
51 C
52 C -----
53 C POINT THREE EXTENDS TRAILER PARALLEL TO GROUND
54 C -----
55 C
56 XL3 = XL2 + 1.0
57 YL3 = YL2
58 ZL3 = ZL2
59 C
60 XR3 = XR2 + 1.0
61 YR3 = YR2
62 ZR3 = ZR2
63 C

```


SUBROUTINE DEVTX

```

64      XT = XT*RADIUS
65      YT = YT*RADIUS
66      C
67      C
68      C -----
69      C CLEAR SCREEN AND HOME CURSOR
70      C -----
71      ICD = 0
72      CALL HOMCLS(ICD)
73      CALL LOCATE(4,1)
74      C
75      C -----
76      C WRITE OUTPUT HEADER
77      C -----
78      C
79      IF(IOUS.NE.IOUS) WRITE(IOUS, ' (''1'') ')
80      C
81      WRITE(IOUS,1000) XT,YT
82      1000 FORMAT( 21X,'DISK VORTEX VELOCITY PROFILE DATA',
83      1 ///,14X,' X-LOCATION (XT)          = ',2X,F8.2,2X,'FT',
84      2  ///,14X,' Y-LOCATION (YT)          = ',2X,F8.2,2X,'FT',/)
85      C
86      C -----
87      C GAMW TO METRIC UNITS OF METERS**2/SEC
88      C -----
89      C
90      GAMWME = GAMW*0.092903
91      C
92      C -----
93      C 5-METER INITIAL CIRCULATION BASED ON 0.1D OR 0.2R CORE SIZE
94      C 5-METERS = 16.4042 FEET
95      C -----
96      C
97      RCD5M = 0.2*RADIUS/16.4042
98      GAMW5M = GAMWME*(1.0 - RCD5M*ATAN(1.0/RCD5M))
99      C
100     WRITE(IOUS,1001) GAMW,GAMWME,GAMW5M
101     1001 FORMAT( 15X,'VORTEX CIRCULATION      = ',F10.2,2X,'FT**2/SEC',/
102     1          15X,'VORTEX CIRCULATION      = ',F10.2,2X,'M**2/SEC',/
103     2          15X,'5-M INITIAL CIRCULATION = ',F10.2,2X,'M**2/SEC')
104     C
105     CHID = CHI*180.0/PI
106     C
107     WRITE(IOUS,1005) CHID
108     1005 FORMAT( 15X,'SETTLING ANGLE          = ',F10.2,2X,'DEG',////)
109     C
110     WRITE(IOUS, ' (23X,A,$) ')
111     1 ' PRESS <RETURN> TO CONTINUE '
112     C
113     READ(IOUS, ' (A1) ') TEMCHAR
114     C
115     CALL HOMCLS(ICD)
116     C
117     IF(IOUS.EQ.6) WRITE(IOUS,93) COMM(1),COMM(2)
118     93 FORMAT( 14X,A50,/,10X,A50,/)
119     C
120     WRITE(IOUS,1100)
121     1100 FORMAT( 12X,'HEIGHT',8X,'MEAN VELOCITY',5X,'MEAN Q',/,
122     1          '0',12X,'(FT)',8X,'(FPS)',6X,'(KN)',5X,'(PSF)',/)
123     C
124     C -----
125     C SET UP SWEEP OF Z AT SPECIFIED X,Y
126     C DELZ AND ZMAX COME FROM A MAINLINE STATUS MENU

```

SUBROUTINE DEVTX

```

127 C -----
128 C
129 XT = XT/RADIUS
130 YT = YT/RADIUS
131 NPTS = IFIX(ZI*AX/DELZ) + 2
132 LINES = 0
133 C
134 DO 200 I=1,NPTS
135 C
136 LINES = LINES + 4
137 ZT = (I - 1)*DELZ
138 C
139 CALL HSVTX(XT,YT,ZT,VXF,VYF,VZF,GAMW,RADIUS)
140 C
141 ZZ = ZT*RADIUS
142 VTF = SQRT(VXF**2 + VYF**2 + VZF**2)
143 VXK = VXF/FPSPKN
144 VYK = VYF/FPSPKN
145 VZK = VZF/FPSPKN
146 VTK = VTF/FPSPKN
147 C
148 QX = RHOD2*VXF**2
149 QY = RHOD2*VYF**2
150 QZ = RHOD2*VZF**2
151 QT = RHOD2*VTF**2
152 C
153 C -----
154 C KEEP OUTPUT PAGE LENGTH TO SIZE OF SCREEN
155 C -----
156 C
157 IF (IOU6.EQ.IOU1) THEN
158 IF (LINES.LE.12) GOTO 100
159 LINES = 4
160 CALL INKEY
161 IF (KEY.NE.'C') GOTO 999
162 WRITE(IOU6,1100)
163 ENDIF
164 C
165 100 CONTINUE
166 C
167 C -----
168 C REPORT X COMPONENT OF VELOCITY
169 C -----
170 C
171 WRITE(IOU6,1101) ZZ,VXF,VXK,QX
172 1101 FORMAT( 9X,F8.2,2X,'X',3F10.3)
173 C
174 C -----
175 C REPORT Y COMPONENT OF VELOCITY
176 C -----
177 C
178 WRITE(IOU6,1102) VYF,VYK,QY
179 1102 FORMAT( 19X,'Y',3F10.3)
180 C
181 C -----
182 C REPORT Z COMPONENT OF VELOCITY
183 C -----
184 C
185 WRITE(IOU6,1103) VZF,VZK,QZ
186 1103 FORMAT( 19X,'Z',3F10.3)
187 C
188 C -----
189 C REPORT TOTAL VELOCITY

```

SUBROUTINE DEVTX

```
190 C -----  
191 C  
192 WRITE(10U6,1104) VTF,VTK,QT  
193 1104 FORMAT( 19X,'T',3F10.3)  
194 C  
195 200 CONTINUE  
196 C  
197 CALL INKEY  
198 C  
199 999 CONTINUE  
200 C  
201 RETURN  
202 END  
203 C
```

SUBROUTINE FREAD

```

1  C
2  C
3  SUBROUTINE FREAD( IOU1,PROMPT,VALUE,CONST)
4  C
5  C *****
6  C SUBROUTINE FREAD PROMPTS USER FOR A FLOATING
7  C POINT DATA ENTRY AND CHECKS VALIDITY OF ENTRY
8  C *****
9  C
10 C
11 C
12 C CHARACTER*50 PROMPT,SHOWIT
13 C CHARACTER*15 ENTRY,BLANK
14 C
15 C DATA BLANK /' /
16 C
17 C *****
18 C
19 C -----
20 C PROMPT USER FOR SCALED FLOATING POINT ENTRY.
21 C FIND POSITION OF LAST NON-BLANK CHARACTER IN PROMPT,
22 C THEN STORE RIGHT JUSTIFIED IN SHOWIT.
23 C -----
24 C
25 C N = LAST + 1
26 C
27 C 10 IF(N.EQ.1)GOTO 20
28 C
29 C N = N - 1
30 C
31 C IF(PROMPT(N:N).EQ.' ')GOTO 10
32 C
33 C 20 JS = LAST - N
34 C
35 C WRITE(SHOWIT,'(50A1)') (' ',J=1,JS),(PROMPT(I:I),I=1,N)
36 C
37 C -----
38 C NOW ASK USER FOR DATA ENTRY
39 C -----
40 C
41 C 30 WRITE(IOU1,'(/,1X,A,G13.6)') SHOWIT,VALUE*CONST
42 C
43 C WRITE(IOU1,'(/,8X,A,$)')
44 C 1 ' ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS --> '
45 C
46 C READ(IOU1,'(A)') ENTRY
47 C
48 C IF(ENTRY.EQ.BLANK)RETURN
49 C
50 C READ(ENTRY,'(BN,F15.0)',ERR=30) TEMP
51 C
52 C -----
53 C CONSTANT CAN BE USED TO SCALE OR
54 C OR CONVERT UNITS OF AN INPUT VALUE
55 C -----
56 C
57 C VALUE = TEMP/CONST
58 C
59 C RETURN
60 C END
61 C

```

SUBROUTINE GDVTX

```

1  C
2  C
3  SUBROUTINE GDVTX(H,RADIUS,AMU,CT,GAMG,XT,YT,DELZ,ZMAX)
4  C
5  C *****
6  C SUBROUTINE GDVTX
7  C
8  C THIS SUBROUTINE LOCATES THE GROUND VORTEX BASED ON THE
9  C EXPERIMENTS BY SUN AND CURTIS (PRINCETON UNIV.), AND THEN
10 C DIRECTS THE CALCULATION OF ITS INDUCED VELOCITY FIELD
11 C
12 C THE OUTPUT FROM THIS SUBROUTINE SHOULD BE USED CAREFULLY
13 C FOR GROSS ESTIMATION PURPOSES ONLY
14 C *****
15 C
16 CHARACTER*1 ICONT(5)
17 CHARACTER*1 TEMCHAR
18 CHARACTER*1 KEY,KKEY
19 CHARACTER*12 PTSFIL(4)
20 CHARACTER*50 COMM(2)
21 C
22 COMMON / CKEY/ KEY,KKEY
23 COMMON /CHSVTX/ XT1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
24 1 XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
25 COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
26 COMMON /INPUTC/ ICONT,COMM,PTSFIL
27 COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
28 C
29 C *****
30 C
31 HOD = H/2.0
32 C1 = 1.0 + 1.2086*HOD**0.4374
33 C2 = -0.2786*HOD**0.6757
34 ZGV = -10.0*AMU + 0.6
35 XGV = -(C1 + C2*(AMU/CT))**2
36 XXGV = XGV*RADIUS
37 ZZGV = ZGV*RADIUS
38 C
39 C -----
40 C ASSUME HORSESHOE SHAPE - ASSIGN LEFT AND RIGHT CORNERS
41 C -----
42 C
43 XL1 = XGV
44 YL1 = -1.0
45 ZL1 = ZGV
46 C
47 XR1 = XGV
48 YR1 = 1.0
49 ZR1 = ZGV
50 C
51 C -----
52 C SET UP DIRECTION POINTERS FOR TRAILER ELEMENTS
53 C -----
54 C
55 XL2 = XL1 + 1.0
56 YL2 = YL1
57 ZL2 = ZL1
58 C
59 XR2 = XR1 + 1.0
60 YR2 = YR1
61 ZR2 = ZR1
62 C
63 XL3 = XL2 + 1.0

```

```

64      YL3 = YL2
65      ZL3 = ZL2
66      C
67      XR3 = XR2 + 1.0
68      YR3 = YR2
69      ZR3 = ZR2
70      C
71      C -----
72      C WRITE OUT GROUND VORTEX POSITION/STRENGTH DATA
73      C -----
74      C
75      IF (IOU6.NE.IOU1) WRITE(IOU6, ' (''1'')' )
76      C
77      WRITE(IOU6,1001) XXGV,ZZGV
78      1001 FORMAT( //,24X,'GROUND VORTEX CORE POSITION',//,
79      1 18X,'X-LOCATION (XXGV)          = ',1X,F8.2,2X,'FT',/
80      2 18X,'Y-LOCATION (ZZGV)          = ',1X,F8.2,2X,'FT')
81      C
82      WRITE(IOU6,1002) GAMG
83      1002 FORMAT( /,18X,'GROUND VORTEX CIRCULATION = ',1X,
84      1      F8.2,2X,'FT**2/SEC',//)
85      C
86      WRITE(IOU1, ' (23X,A,S)' )
87      1 ' PRESS <RETURN> TO CONTINUE '
88      C
89      READ(IOU1, ' (A1)' ) TEMCHAR
90      C
91      ICD = 0
92      CALL HOMCLS(ICD)
93      C
94      C -----
95      C WRITE OUTPUT HEADER
96      C -----
97      C
98      IF (IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
99      93 FORMAT( 14X,A50,/,10X,A50,//)
100     C
101     WRITE(IOU6,1100)
102     1100 FORMAT( 12X,'HEIGHT',8X,'MEAN VELOCITY',5X,'MEAN Q',/,
103     1      ' 0',12X,' (FT)',8X,' (FPS)',6X,' (KN)',5X,' (PSF)',/)
104     C
105     C -----
106     C SET UP SWEEP OF Z AT SPECIFIED X,Y
107     C DELZ AND ZMAX COME FROM MAINLINE STATUS SCREEN
108     C -----
109     C
110     NPTS = IFIX(ZMAX/DELZ) + 2
111     LINES = 0
112     C
113     DO 200 I=1,NPTS
114     C
115     LINES = LINES + 4
116     ZT = (I - 1)*DELZ
117     C
118     CALL HSVTX(XT,YT,ZT,VXF,VYF,VZF,GAMG,RADIUS)
119     C
120     ZZ = ZT*RADIUS
121     VTF = SQRT(VXF**2 + VYF**2 + VZF**2)
122     VXK = VXF/FPSPKN
123     VYK = VYF/FPSPKN
124     VZK = VZF/FPSPKN
125     VTK = VTF/FPSPKN
126     C

```

SUBROUTINE GDVTX

```

127      QX = RHOD2*VXF**2
128      QY = RHOD2*VYF**2
129      QZ = RHOD2*VZF**2
130      QT = RHOD2*VTF**2
131  C
132      IF (IOU6.EQ.IOU1) THEN
133          IF (LINES.LE.12) GOTO 100
134          LINES = 4
135          CALL INKEY
136          IF (KEY.NE.'C') GOTO 999
137          WRITE(IOU6,1100)
138      ENDIF
139  C
140      100 CONTINUE
141  C
142  C -----
143  C REPORT X COMPONENT OF VELOCITY
144  C -----
145  C
146      WRITE(IOU6,1101) ZZ,VXF,VXK,QX
147      1101 FORMAT( 9X,F8.2,2X,'X',3F10.3)
148  C
149  C -----
150  C REPORT Y COMPONENT OF VELOCITY
151  C -----
152  C
153      WRITE(IOU6,1102) VYF,VYK,QY
154      1102 FORMAT( 19X,'Y',3F10.3)
155  C
156  C -----
157  C REPORT Z COMPONENT OF VELOCITY
158  C -----
159  C
160      WRITE(IOU6,1103) VZF,VZK,QZ
161      1103 FORMAT( 19X,'Z',3F10.3)
162  C
163  C -----
164  C REPORT TOTAL VELOCITY
165  C -----
166  C
167      WRITE(IOU6,1104) VTF,VTK,QT
168      1104 FORMAT( 19X,'T',3F10.3)
169  C
170      200 CONTINUE
171  C
172      CALL INKEY
173  C
174      999 CONTINUE
175  C
176      RETURN
177      END
178  C

```

SUBROUTINE HAZARD

```

1  C
2  C
3  SUBROUTINE HAZARD (HAZTYP)
4  C
5  C *****
6  C SUBROUTINE HAZARD IS THE MAINLINE DRIVER FOR THE
7  C CALCULATION OF SPECIFIC HAZARDS
8  C *****
9  C
10 C
11 C   PARAMETER (NUM1 = 6)
12 C   PARAMETER (NUM2 = 15)
13 C   PARAMETER (NUM3 = 4)
14 C   PARAMETER (NUM4 = 4)
15 C
16 C   CHARACTER*1 OKLST1 (NUM1)
17 C   CHARACTER*1 OKLST2 (NUM2)
18 C   CHARACTER*1 OKLST3 (NUM3)
19 C   CHARACTER*1 OKLST4 (NUM4)
20 C
21 C   CHARACTER*1 KEY, KKEY, HAZTYP, HUMTYP
22 C   CHARACTER*1 CHDOL, CVALUE
23 C   CHARACTER*1 ICONT (5)
24 C   CHARACTER*12 PTSFIL (4)
25 C   CHARACTER*12 TMPFIL
26 C   CHARACTER*50 COMM (2)
27 C   CHARACTER*50 PROMPT
28 C
29 C   DIMENSION COL (9), CONTV (7), CONTX (8)
30 C
31 C   COMMON / CKEY/ KEY, KKEY
32 C   COMMON / CONSTS/ PI, RHO, FPSPKN, RHOD2, DRC
33 C   COMMON / HELGEO/ H, DL, YSEP, WSPD, RADIUS, SHFTAN, DXO
34 C   COMMON / INPUTC/ ICONT, COMM, PTSFIL
35 C   COMMON / INPUTD/ CONT, CONTV, CONTX, YBDLAY
36 C   COMMON / PROFIL/ RJ, ZBJ, ZHJ, ZMJ, UMJ, ZB, ZH, ZM, UM, CU, CY
37 C   COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
38 C *****
39 C
40 C   DATA OKLST1 / 'C', 'c', 'M', 'm', 'X', 'x' /
41 C   DATA OKLST2 / ' ', 'A', 'a', 'B', 'b', 'C', 'c', 'D', 'd',
42 C   DATA OKLST3 / 'E', 'e', 'F', 'f', 'G', 'g' /
43 C   DATA OKLST4 / 'W', 'w', 'I', 'i' /
44 C   DATA OKLST4 / 'L', 'l', 'S', 's' /
45 C
46 C   -----
47 C   CLEAR SCREEN AND HOME CURSOR
48 C   -----
49 C
50 C   ICD = 0
51 C   CALL HOMCLS (ICD)
52 C   CALL LOCATE (4, 1)
53 C
54 C   -----
55 C   DETERMINE THE TYPE OF HAZARD ANALYSIS
56 C   OPTION THAT WILL BE EXECUTED
57 C   -----
58 C
59 C   WRITE (IOU1, 10)
60 C   10 FORMAT ( 25X, ' SELECT TYPE OF HAZARD', ///,
61 C   1      18X, ' OVERTURNING FORCE/MOMENT,          TYPE <M>', /,
62 C   2      18X, ' PARTICULATE CLOUDS,              TYPE <C>', /,
63 C   3      18X, ' TO EXIT PROGRAM,                  TYPE <X>', /)

```


SUBROUTINE HAZARD

```

64 C
65 C -----
66 C INQUIRE, OBTAIN, AND CHECK FOR VALID MENU CODE
67 C -----
68 C
69 C 11 CONTINUE
70 C
71 C WRITE(IOU1,'(23X,A,$)') ' ENTER HAZARD CODE ==> '
72 C
73 C READ(IOU1,'(A1)') HAZTYP
74 C
75 C IF(LEGAL(HAZTYP,IOU1,OKLST1,NUM1).EQ.1)GOTO 11
76 C
77 C -----
78 C CORRECT LOWER CASE LETTERS TO UPPER CASE
79 C TO USE AS VALID FLAGS IN PARENT SUBROUTINE
80 C -----
81 C
82 C IF(HAZTYP.EQ.'c') HAZTYP = 'C'
83 C IF(HAZTYP.EQ.'m') HAZTYP = 'M'
84 C IF(HAZTYP.EQ.'x') HAZTYP = 'X'
85 C
86 C -----
87 C BRANCH IF EXIT OPTION CHOSEN
88 C -----
89 C
90 C IF(HAZTYP.EQ.'M')GOTO 18
91 C IF(HAZTYP.EQ.'C')GOTO 18
92 C IF(HAZTYP.EQ.'X')GOTO 999
93 C
94 C GOTO 11
95 C
96 C 18 CONTINUE
97 C
98 C *****
99 C RADIAL WALL JET FLOW INFORMATION
100 C *****
101 C
102 C -----
103 C ACCELERATED SLIPSTREAM MEAN VELOCITY
104 C -----
105 C
106 C UN = SQRT(2.0*DL/RHO)
107 C
108 C -----
109 C GROUND EFFECT CORRECTION
110 C -----
111 C
112 C AKG = 1.0 - 0.9*EXP(-2.0*H)
113 C
114 C -----
115 C MEAN VELOCITY AT ROTOR DISK (RATIOED TO UN)
116 C -----
117 C
118 C UB = AKG/2.0
119 C
120 C -----
121 C FIND INITIAL RADIUS OF WALL JET
122 C -----
123 C
124 C CALL WALJET(H,UB,UN,UMB)
125 C
126 C 500 CONTINUE

```

SUBROUTINE HAZARD

```

127 C
128 IF (KEY.EQ.'X') GOTO 999
129 IF (KEY.EQ.'N') GOTO 999
130 C
131 C -----
132 C BRANCH IF CLOUD OPTION CHOSEN
133 C -----
134 C
135 IF (HAZTYP.EQ.'C') GOTO 800
136 C
137 C *****
138 C OVERTURNING FORCES/MOMENTS
139 C *****
140 C
141 C -----
142 C DETERMINE:
143 C
144 C 1. THE AXIS ALONG WHICH THE OVERTURNING
145 C FORCES/MOMENTS WILL BE CALCULATED
146 C
147 C 2. THE SIZE OF THE PERSON AFFECTED
148 C
149 C 3. THE DISTANCES AT WHICH THE OVERTURNING
150 C FORCES/MOMENTS WILL BE CALCULATED
151 C -----
152 C
153 20 CONTINUE
154 C
155 ICD = 0
156 CALL HOMCLS(ICD)
157 CALL LOCATE(2,1)
158 C
159 WRITE(IOU1,12)
160 12 FORMAT( 20X,' OVERTURNING FORCE/MOMENT DATA MENU',//,
161 1 10X,'CODE' PARAMETER VALUE',
162 2 ' UNITS',/)
163 C
164 C -----
165 C PRINT OUT MENU VARIABLES AS BASED ON THE WALL JET
166 C OPTION OR INTERACTION PLANE OPTION SWITCH SETTING
167 C -----
168 C
169 IF (ICONT(4).EQ.'W') THEN
170 C
171 WRITE(IOU1,14) ICONT(4),ICONT(5),PTSFIL(3),
172 1 CONTV(4),CONTV(5),CONTV(6),YBDLAY
173 C
174 ELSE
175 C
176 WRITE(IOU1,14) ICONT(4),ICONT(5),PTSFIL(4),
177 1 CONTV(4),CONTV(5),CONTV(6),YBDLAY
178 C
179 ENDIF
180 C
181 14 FORMAT( 11X,'A <W>ALL JET OR <I>INTERACTION PLANE',5X,A2,//,
182 1 11X,'B <L>ARGE OR <S>MALL PERSON',5X,A2,//,
183 2 11X,'C DATA OUTPUT FILENAME',2X,A12,//,
184 3 11X,'',//,
185 4 11X,'D INITIAL STATION POSITION',5X,F7.2,4X,'FT',//,
186 5 11X,'E HORIZONTAL INCREMENT',5X,F7.2,4X,'FT',//,
187 6 11X,'F MAXIMUM STATION POSITION',5X,F7.2,4X,'FT',//,
188 6 11X,'G MINIMUM BOUNDARY LAYER HEIGHT',5X,F7.2,4X,'FT',//)
189 C

```

SUBROUTINE HAZARD

```

190 C -----
191 C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
192 C -----
193 C
194 C 16 CONTINUE
195 C
196 C WRITE(IOU1,'(8X,A,$)')
197 C 1' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
198 C
199 C READ(IOU1,'(A1)') CHDOL
200 C
201 C IF(LEGAL(CHDOL,IOU1,OKLST2,NUM2).EQ.1)GOTO 16
202 C
203 C -----
204 C DIRECT OPTIONS BASED ON CHOICE FOR "CHDOL"
205 C -----
206 C
207 C IF(CHDOL.EQ.' ')GOTO 30
208 C
209 C -----
210 C CHOOSE WALJET OR IPLANE OPTION
211 C -----
212 C
213 C IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
214 C
215 C 40 CONTINUE
216 C
217 C WRITE(IOU1,'(/,35X,A,1X,A2/)') ' ANALYSIS TYPE = ',ICONT(4)
218 C WRITE(IOU1,'(37X,A,$)') ' ENTER NEW CODE ==> '
219 C READ(IOU1,'(A1)') CVALUE
220 C
221 C IF(LEGAL(CVALUE,IOU1,OKLST3,NUM3).EQ.1)GOTO 40
222 C
223 C ICONT(4) = CVALUE
224 C IF(ICONT(4).EQ.'w') ICONT(4) = 'W'
225 C IF(ICONT(4).EQ.'i') ICONT(4) = 'I'
226 C GOTO 20
227 C
228 C ENDIF
229 C
230 C -----
231 C CHOOSE LARGE OR SMALL PERSON
232 C -----
233 C
234 C IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
235 C
236 C 41 CONTINUE
237 C
238 C WRITE(IOU1,'(/,35X,A,1X,A2/)') ' PERSON TYPE = ',ICONT(5)
239 C WRITE(IOU1,'(37X,A,$)') ' ENTER NEW CODE ==> '
240 C READ(IOU1,'(A1)') CVALUE
241 C
242 C IF(LEGAL(CVALUE,IOU1,OKLST4,NUM4).EQ.1)GOTO 41
243 C
244 C ICONT(5) = CVALUE
245 C IF(ICONT(5).EQ.'l') ICONT(5) = 'L'
246 C IF(ICONT(5).EQ.'s') ICONT(5) = 'S'
247 C GOTO 20
248 C
249 C ENDIF
250 C
251 C -----
252 C CHOOSE GRAPHICS FILENAME

```

SUBROUTINE HAZARD

```

253 C -----
254 C
255 IF (CHDOL.EQ.'C'.OR.CHDOL.EQ.'c') THEN
256 C
257     IF (ICONT(4).EQ.'W') THEN
258         WRITE(IOU1,'(/,25X,A,1X,A12/)' )
259     1 ' FILENAME = ',PTSFIL(3)
260     ELSE
261         WRITE(IOU1,'(/,25X,A,1X,A12/)' )
262     1 ' FILENAME = ',PTSFIL(4)
263     ENDIF
264 C
265     WRITE(IOU1,'(20X,A,$)' )
266 1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) ==> '
267 C
268     READ(IOU1,'(A12)') TMPFIL
269 C
270     IF (ICONT(4).EQ.'W') PTSFIL(3) = TMPFIL
271     IF (ICONT(4).EQ.'I') PTSFIL(4) = TMPFIL
272     GOTO 20
273 C
274     ENDIF
275 C
276 C -----
277 C CHOOSE INITIAL STATION POSITION
278 C -----
279 C
280 IF (CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
281 C
282     PROMPT = 'INITIAL STATION POSITION = '
283     CALL FREAD(IOU1,PROMPT,CONTV(4),1.0)
284 C
285     IF (CONTV(4).LT.0.0) CONTV(4) = 0.0
286     GOTO 20
287 C
288     ENDIF
289 C
290 C -----
291 C CHOOSE HORIZONTAL INCREMENT
292 C -----
293 C
294 IF (CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
295 C
296     PROMPT = 'HORIZONTAL INCREMENT = '
297     CALL FREAD(IOU1,PROMPT,CONTV(5),1.0)
298 C
299     IF (CONTV(5).LT.0.0) CONTV(5) = 0.0
300     GOTO 20
301 C
302     ENDIF
303 C
304 C -----
305 C CHOOSE HORIZONTAL INCREMENT
306 C -----
307 C
308 IF (CHDOL.EQ.'F'.OR.CHDOL.EQ.'f') THEN
309 C
310     PROMPT = 'MAXIMUM STATION POSITION = '
311     CALL FREAD(IOU1,PROMPT,CONTV(6),1.0)
312 C
313     IF (CONTV(6).LT.CONTV(4)) CONTV(6) = CONTV(4)
314     GOTO 20
315 C

```

SUBROUTINE HAZARD

```

316      ENDIF
317      C
318      IF (CHDOL.EQ.'G'.OR.CHDOL.EQ.'g') THEN
319      C
320          PROMPT = 'MINIMUM BOUNDARY LAYER HEIGHT = '
321          CALL FREAD(IOU1,PROMPT,YBDLAY,1.0)
322      C
323          IF (YBDLAY.LT.0.0) YBDLAY = 0.0
324          GOTO 20
325      C
326      ENDIF
327      C
328      GOTO 20
329      C
330      30 CONTINUE
331      C
332          ICD = 0
333          CALL HOMCLS(ICD)
334      C
335          IF (ICONT(4).EQ.'I') GOTO 700
336      C
337      600 CONTINUE
338      C
339      C -----
340      C WALL JET REGION
341      C
342      C OBTAIN DATA FOR THE HWJVEL OPTION
343      C -----
344      C
345          RVZ      = (CONTV(4) - DXO)/RADIUS
346          DELH     = CONTV(5)
347          HMAX     = CONTV(6)
348          HUMTYP   = ICONT(5)
349          BDLAYM   = YBDLAY/RADIUS
350      C
351      C -----
352      C GENERATE VELOCITY PROFILE AT RVZ IN WALL JET REGION
353      C -----
354      C
355          CALL
356      HWJVEL(H,UN,UMB,RVZ,RADIUS,WSPD,DELH,HMAX,HUMTYP,DXO,BDLAYM)
357      C
358          GOTO 500
359      C
360      700 CONTINUE
361      C
362      C -----
363      C INTERACTION PLANE UPWASH DEFLECTION ZONE
364      C
365      C OBTAIN INPUT DATA FOR THE HIPVEL OPTION
366      C -----
367      C
368          XIP      = (CONTV(4) - DXO)/RADIUS
369          DELH     = CONTV(5)
370          HMAX     = CONTV(6)
371          HUMTYP   = ICONT(5)
372          BDLAYM   = YBDLAY/RADIUS
373      C
374      C -----
375      C GENERATE VELOCITY PROFILE AT XIP IN INTERACTION PLANE
376      C -----
377      C
378          CALL HIPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELH,HMAX,

```

SUBROUTINE HAZARD

```
379      *          HUMTYP, DXO, BDLAYM)
380      C
381          GOTO 500
382      C
383      800 CONTINUE
384      C
385      C *****
386      C CALCULATE PARTICULATE CLOUD BOUNDARIES
387      C *****
388      C
389      CALL CLOUD (UN, UMB)
390      C
391      GOTO 500
392      C
393      C -----
394      C NORMAL PROGRAM EXIT
395      C -----
396      C
397      999 CONTINUE
398      C
399      RETURN
400      END
401      C
```

SUBROUTINE HIPVEL

```

1  C
2  C
3      SUBROUTINE HIPVEL(H,UN,RADIUS,UMB,XIP,YSEP,WSPD,DELH,
4      *                      HMAX,HUMTYP,DXO,BDLAYM)
5  C
6  C
7      *****
8  C      SUBROUTINE HIPVEL GENERATES THE VELOCITY PROFILE AND THE FORCES
9  C      AND OVERTURNING MOMENTS FOR A HUMAN BEING ALONG THE INTERACTION
10 C      PLANE FOR THE TWIN ROTOR CASE
11 C
12 *****
13 C
14     CHARACTER*1 TEMCHAR
15     CHARACTER*1 KEY,KKEY,HUMTYP
16     CHARACTER*1 ICONT(5)
17     CHARACTER*12 PTSFIL(4)
18     CHARACTER*50 COMM(2)
19 C
20     COMMON / CKEY/ KEY,KKEY
21     COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
22     COMMON /INPUTC/ ICONT,COMM,PTSFIL
23     COMMON /PERSON/ QP(12),DSET
24     COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
25     COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
26 C
27 C
28 *****
29 C
30     ICD = 0
31     CALL HOMCLS(ICD)
32 C
33 C      -----
34 C      INPUT FOR DELH AND HMAX COMES FROM INPUTV STATUS MENU
35 C      -----
36 C
37     DSET = DELH
38     IF(DSET.EQ.0.)DELH = HMAX
39 C
40     DELH = DELH/RADIUS
41     HMAX = HMAX/RADIUS
42     NHPTS = IFIX((HMAX - XIP)/DELH) + 1
43 C
44     IF(DSET.EQ.0.)GOTO 33
45 C
46 C      -----
47 C      WRITE OUTPUT HEADER (FOR PLOT FILE, SEE BELOW)
48 C      -----
49 C
50     IF(IOU6.NE.IOU1) WRITE(IOU6,(''1''))
51 C
52     IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
53     93 FORMAT( 10X,A50,/,10X,A50,/)
54 C
55     WRITE(IOU6,1001)
56     1001 FORMAT( 12X,' SUMMARY OF OVERTURNING FORCES AND MOMENTS',/,
57     1          19X,'RADIUS',6X,'TOTF',6X,'TOTM',/,
58     2          20X,'(FT)',7X,'(LB)',5X,'(FT-LB)',/,
59     33 CONTINUE
60 C
61 C      -----
62 C      WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER
63 C      -----

```

SUBROUTINE HIPVEL

```

64 C
65 IF (IGRAPH.EQ.1) THEN
66 C
67 C -----
68 C OPEN GRAPHICS FILE AND WRITE FILE HEADER
69 C -----
70 C
71 OPEN(1008,FILE=PTSFIL(4),STATUS='NEW',ERR=2000)
72 C
73 WRITE(1008,83) COMM(1),COMM(2)
74 83 FORMAT( 10X,A50,/,10X,A50,/)
75 C
76 WRITE(1008,80)
77 80 FORMAT( 1X,'TITLE="TWIN ROTOR DAIP DATA"')
78 C
79 WRITE(1008,81)
80 81 FORMAT( 1X,'VARIABLES = DAIP,TOTF,TOTM')
81 C
82 WRITE(1008,88)
83 88 FORMAT( 1X,'ZONE T = "GW = xxxxx LB, WAGL = xx FT",',
84 * ' I=X, F=POINT')
85 C
86 ENDIF
87 C
88 C -----
89 C BEGIN LOOP INCREMENTING THE RADIAL POINTS AT WHICH
90 C THE OVERTURNING MOMENT CALCULATIONS ARE MADE
91 C -----
92 C
93 DO 565 K = 1,NHPTS
94 C
95 C -----
96 C TF IS INTERACTION PLANE AMPLIFICATION FACTOR
97 C (SEE NOTE IN IPVEL.FOR FOR VERSION 2.1)
98 C -----
99 C
100 TF = 1.65 - (0.65)*EXP(-0.5*XIP)
101 C
102 C -----
103 C GET PARAMETERS AT BASE RADIUS FOR 'BOUNDARY LAYER'
104 C -----
105 C
106 RIP0 = SQRT(XIP**2 + YSEP**2)
107 C
108 C -----
109 C 'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
110 C OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
111 C -----
112 C
113 CALL PROPRM(H,UMB,RIP0)
114 C
115 ZIPB = ZB
116 ZIPM = ZM
117 ZIPH = ZH
118 C
119 RIPM = SQRT(XIP**2 + (YSEP + ZIPM)**2)
120 C
121 CALL PROPRM(H,UMB,RIPM)
122 C
123 UMM = UM
124 C
125 C -----
126 C OUTPUT HEADER

```


SUBROUTINE HIPVEL

```

127 C -----
128 C
129 IF(DSET.NE.0.)GOTO 78
130 C
131 XXIP = RADIUS*XIIP
132 XIPOUT = XXIP + DYO
133 C
134 IF(IOUS.NE.IOUS) WRITE(IOUS,(''1''))
135 C
136 IF(IOUS.EQ.6) WRITE(IOUS,93) COMM(1),COMM(2)
137 C
138 WRITE(IOUS,1000) XIPOUT
139 1000 FORMAT( 2X,'TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE',
140 1 ' AT DISTANCE = ',F7.1,' FT',//)
141 C
142 WRITE(IOUS,1002)
143 1002 FORMAT( 3X,'HEIGHT',6X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
144 1 'MEAN Q',4X,'PEAK Q',/,
145 2 3X,'(FT)',7X,'(FPS)',6X,'(KN)',5X,'(FPS)',6X,'(KN)',5X,
146 3 '(PSF)',5X,'(PSF)',/)
147 78 CONTINUE
148 C
149 C -----
150 C 'AN' IS ACTUALLY '= 1.0/7.0'
151 C -----
152 C
153 AN = 0.142857142
154 C
155 DELZ = 0.5/RADIUS
156 NPTS = 12
157 C
158 DO 500 I = 1,NPTS
159 C
160 ZIP = DELZ*(I - 1) + (0.25/RADIUS)
161 C
162 C -----
163 C GET MAX WALL JET VELOCITY AT EFFECTIVE RADIUS
164 C -----
165 C
166 RIP = SQRT(XIP**2 + (YSEP + ZIP)**2)
167 C
168 CALL PROPRM(H,UMB,RIP)
169 C
170 VN = UN
171 VZ = UM
172 C
173 C -----
174 C INTERACTION PLANE 'BOUNDARY LAYER'
175 C
176 C CODE MODIFIED IN MAY 1992 FOR USER SPECIFIED
177 C MINIMUM BOUNDARY LAYER THICKNESS (BDLAYM)
178 C -----
179 C
180 ZIP1 = BDLAYM
181 C
182 IF(ZIP.LT.ZIPM.OR.ZIP.LT.ZIP1)THEN
183 C
184 IF(ZIP1.LT.ZIPM)THEN
185 C
186 VZ = UMM*(ZIP/ZIPM)**AN
187 C
188 ELSE
189 C

```

SUBROUTINE HIPVEL

```

190          VZ = UMM*(ZIP/ZIP1)**AN
191      C
192          ENDIF
193      C
194      ENDIF
195      C
196      C -----
197      C DEVELOPED INTERACTION PLANE JET
198      C -----
199      C
200      VH = TF*VZ*XIP/RIP
201      VV = TF*VZ*(YSEP + ZIP)/RIP
202      C
203      ZZ = ZIP*RADIUS
204      C
205      C -----
206      C MEAN HORIZONTAL VELOCITIES AND DYNAMIC PRESSURE
207      C -----
208      C
209      VHMF = VH*UN
210      VHMK = VHMF/FPSPKN
211      C
212      C -----
213      C PEAK VELOCITIES (BOTH FT/SEC AND KNOTS)
214      C
215      C EQUATION FOR VMFD3I UPDATED FROM 1st TO
216      C 2nd ORDER POLYNOMIAL FOR VERSION 2.1
217      C -----
218      C
219      VMFD3I = 0.712887 + 0.304369*XIP - 0.018496*XIP*XIP
220      C
221      IF(VMFD3I.LT.1.2) VMFD3I = 1.2
222      C
223      VHPF = VMFD3I*VHMF
224      VHPK = VHPF/FPSPKN
225      C
226      C -----
227      C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
228      C (UPWIND SIDE) 'XKW' TIMES THE AMBIENT WIND VELOCITY TO
229      C THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
230      C -----
231      C
232      XKW = (-0.5*N) + 2.5
233      C
234      IF(XKW.LT.1.0) XKW = 1.0
235      C
236      WSPD2 = WSPD*XKW
237      VHMK = VHMK + WSPD2
238      VHMF = VHMK*FPSPKN
239      VHPK = VHPK + WSPD2
240      VHPF = VHPK*FPSPKN
241      C
242      C -----
243      C DYNAMIC PRESSURE
244      C -----
245      C
246      QHM = RHOD2*VHMF**2
247      QP(I) = RHOD2*VHPF**2
248      C
249      IF(DSET.NE.0.)GOTO 77
250      C
251      C -----
252      C REPOPT HORIZONTAL COMPONENTS

```

SUBROUTINE HIPVEL

```

253 C -----
254 C
255 WRITE(IOUS,1003) ZZ,VHMF,VHMK,VHPF,VHPK,QHM,QP(I)
256 1003 FORMAT ( F8.2,2X,6F10.3)
257 77 CONTINUE
258 C
259 500 CONTINUE
260 C
261 IF(DSET.NE.0.)GOTO 520
262 WRITE(IOUS,73)
263 73 FORMAT( )
264 C
265 WRITE(IOUS,'(19X,A,$)')
266 1 ' TYPE <RETURN> TO CONTINUE
267 C
268 READ(IOUS,'(A1)') TEMCHAR
269 C
270 ICD = 0
271 CALL HOMCLS(ICD)
272 IF(IOUS.NE.IOUS) WRITE(IOUS,'(''1'')')
273 C
274 IF(IOUS.EQ.6) WRITE(IOUS,93) COMM(1),COMM(2)
275 C
276 WRITE(IOUS,1007) XIPOUT
277 1007 FORMAT( 12X,'TWIN ROTOR FORCE PROFILE AT DISTANCE = ',
278 1 F7.1,' FT',//)
279 WRITE(IOUS,1008)
280 1008 FORMAT( 2X,'HEIGHT',6X,'PEAK Q',6X,'FOVER',7X,'OVERM',7X,
281 1 'TOT F',7X,'TOT M',/,
282 2 3X,'(FT)',8X,'(PSF)',7X,'(LB)',6X,'(FT-LB)',7X,
283 3 '(LB)',6X,'(FT-LB)',/,)
284 520 CONTINUE
285 C
286 C -----
287 C CALL SUBROUTINE TO CALCULATE THE
288 C FORCES AND MOMENTS ON A HUMAN BEING
289 C -----
290 C
291 CALL MOMENT(NPTS,HUMTYP,TOTF,TOTM)
292 C
293 IF(DSET.EQ.0.)GOTO 545
294 C
295 HH = XIP*RADIUS
296 HHOUT = HH + DXO
297 C
298 WRITE(IOUS,1014) HHOUT,TOTF,TOTM
299 1014 FORMAT( 10X,F8.2,2F10.3)
300 C
301 IF(IGRAPH.EQ.1)THEN
302 C
303 WRITE(IOUS,90) HHOUT,TOTF,TOTM
304 90 FORMAT( 1X,F7.2,1X,F7.2,1X,F8.2)
305 C
306 ENDIF
307 C
308 545 CONTINUE
309 C
310 XIP = XIP + DELH
311 C
312 565 CONTINUE
313 C
314 C -----
315 C CLOSE AN OPEN GRAPHICS FILE

```

SUBROUTINE HIPVEL

```

316 C -----
317 C
318 C IF(IGRAPH.EQ.1)THEN
319 C
320 C     CLOSE(IOUS,STATUS='KEEP')
321 C
322 C     ENDIF
323 C
324 C     CALL INKEY
325 C
326 C     GOTO 999
327 C
328 C -----
329 C THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
330 C OPEN ERRORS BY RETURNING THE USER TO A MENU
331 C -----
332 C
333 C 2000 CONTINUE
334 C
335 C     CALL HOMCLS(0)
336 C     WRITE(IOUS,2001)
337 C 2001 FORMAT( ///,8X,
338 C 1 ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
339 C 2 ///,8X,' TYPE <RETURN> TO CONTINUE ', $)
340 C     READ(IOUS,'(A1)') TEMCHAR
341 C     KEY = 'P'
342 C
343 C 999 CONTINUE
344 C
345 C     RETURN
346 C     END
347 C
348 C

```

SUBROUTINE HOMCLS

```

1  C
2  C
3  SUBROUTINE HOMCLS(CODE)
4  C
5  C *****
6  C SUBROUTINE HOMCLS
7  C
8  C THIS SUBROUTINE HOMES THE CURSOR AND CLEARS THE TERMINAL
9  C SCREEN (CODE=0) OR HOMES THE CURSOR ONLY (CODE=1)
10 C *****
11 C
12 COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
13 C
14 INTEGER*4 CODE
15 C
16 CHARACTER*4 ED
17 CHARACTER*1 EED(4)
18 EQUIVALENCE (ED,EED(1))
19 C
20 CHARACTER*3 EE
21 CHARACTER*1 EEE(3)
22 EQUIVALENCE (EE,EEE(1))
23 C
24 C *****
25 C
26 IF(CODE.EQ.0)GOTO 20
27 C
28 C -----
29 C HOME CURSOR AND CLEAR SCREEN
30 C ANSI CONTROL SEQUENCE: ED = ESC[2J
31 C -----
32 C
33 EED(1) = CHAR(27)
34 EED(2) = CHAR(91)
35 EED(3) = CHAR(50)
36 EED(4) = CHAR(74)
37 C
38 WRITE(IOU1,*) ED
39 C
40 20 CONTINUE
41 C
42 C -----
43 C HOME CURSOR ONLY
44 C ANSI CONTROL SEQUENCE: EE = ESC[H
45 C -----
46 C
47 EEE(1) = CHAR(27)
48 EEE(2) = CHAR(91)
49 EEE(3) = CHAR(72)
50 C
51 WRITE(IOU1,*) EE
52 C
53 RETURN
54 END
55 C

```

SUBROUTINE HSVTX

```

1  C
2  C
3      SUBROUTINE HSVTX(XT,YT,ZT,VX,VY,VZ,GAMMA,RADIUS)
4  C
5  C
6  *****
7  C      SUBROUTINE HSVTX
8  C
9  C      THIS SUBROUTINE DIRECTS THE CALCULATION OF THE INDUCED VELOCITY
10 C      FIELD DUE TO A HORSESHOE VORTEX SYSTEM OF UNIT STRENGTH.  POINT
11 C      :
12 C      (LEFT = L1, RIGHT = R1) DEFINE THE EXTENT OF THE BOUND PORTION
13 C      OF
14 C      THE HORSESHOE.  THE TRAILERS START AT POINT 1 AND EXTEND
15 C      THROUGH
16 C      POINT 2, AND THEN ON TO POINT 3.  THIS ALLOWS TWO ELEMENTS FOR
17 C      EACH TRAILER SO THAT IT CAN 'BEND' TO ACCOUNT FOR GROUND
18 C      CONTACT.
19 C
20 C      *****
21 C
22 C      COMMON /CHSVTX/  XL1,YL1,ZL1,XL2,YL2,ZL2,XL3,YL3,ZL3,
23 C      1  XR1,YR1,ZR1,XR2,YR2,ZR2,XR3,YR3,ZR3
24 C      COMMON /CVLINE/  IFI,XA,YA,ZA,XB,YB,ZB,XC,YC,ZC,Q1,Q2,Q3
25 C
26 C
27 C      *****
28 C
29 C      -----
30 C      AT SPECIFIED (X,Y,Z) TARGET POINT IN VICINITY
31 C      OF ROTOR, CALCULATE THE VECTOR VELOCITY
32 C      -----
33 C
34 C      VX = 0.0
35 C      VY = 0.0
36 C      VZ = 0.0
37 C
38 C      XC = XT
39 C      YC = YT
40 C      ZC = ZT
41 C
42 C      -----
43 C      LEFT TRAILER CONTRIBUTION, POINT 1 TO POINT 2
44 C      -----
45 C
46 C      IFI = 0
47 C      XA = XL1
48 C      YA = YL1
49 C      ZA = ZL1
50 C      XB = XL2
51 C      YB = YL2
52 C      ZB = ZL2
53 C
54 C      CALL VLINE
55 C
56 C      VX = VX - Q1
57 C      VY = VY - Q2
58 C      VZ = VZ - Q3
59 C
60 C      -----
61 C      LEFT TRAILER IMAGE
62 C      -----
63 C

```

SUBROUTINE HSVTX

```

64      ZA = -ZA
65      ZB = -ZB
66      C
67      CALL VLINE
68      C
69      VX = VX + Q1
70      VY = VY + Q2
71      VZ = VZ + Q3
72      C
73      C
74      C-----
75      C LEFT TRAILER CONTRIBUTION, POINT 2 TO POINT 3
76      C-----
77      IFI = 1
78      XA = XL2
79      YA = YL2
80      ZA = ZL2
81      XB = XL3
82      YB = YL3
83      ZB = ZL3
84      C
85      CALL VLINE
86      C
87      VX = VX - Q1
88      VY = VY - Q2
89      VZ = VZ - Q3
90      C
91      C
92      C-----
93      C LEFT TRAILER IMAGE
94      C-----
95      ZA = -ZA
96      ZB = -ZB
97      C
98      CALL VLINE
99      C
100     VX = VX + Q1
101     VY = VY + Q2
102     VZ = VZ + Q3
103     C
104     C
105     C-----
106     C SPANWISE VORTEX CONTRIBUTION
107     C-----
108     IFI = 0
109     XA = XL1
110     YA = YL1
111     ZA = ZL1
112     XB = XR1
113     YB = YR1
114     ZB = ZR1
115     C
116     CALL VLINE
117     C
118     VX = VX + Q1
119     VY = VY + Q2
120     VZ = VZ + Q3
121     C
122     C
123     C-----
124     C SPANWISE VORTEX IMAGE
125     C-----
126     ZA = -ZA

```

SUBROUTINE HSVTX

```
127      ZB = -ZB
128      C
129      CALL VLINE
130      C
131      VX = VX - Q1
132      VY = VY - Q2
133      VZ = VZ - Q3
134      C
135      C -----
136      C RIGHT TRAILER CONTRIBUTION, POINT 1 TO POINT 2
137      C -----
138      C
139      IFI = 0
140      XA = XR1
141      YA = YR1
142      ZA = ZR1
143      XB = XR2
144      YB = YR2
145      ZB = ZR2
146      C
147      CALL VLINE
148      C
149      VX = VX + Q1
150      VY = VY + Q2
151      VZ = VZ + Q3
152      C
153      C -----
154      C RIGHT TRAILER IMAGE
155      C -----
156      C
157      ZA = -ZA
158      ZB = -ZB
159      C
160      CALL VLINE
161      C
162      VX = VX - Q1
163      VY = VY - Q2
164      VZ = VZ - Q3
165      C
166      C -----
167      C RIGHT TRAILER CONTRIBUTION, POINT 2 TO POINT 3
168      C -----
169      C
170      IFI = 1
171      XA = XR2
172      YA = YR2
173      ZA = ZR2
174      XB = XR3
175      YB = YR3
176      ZB = ZR3
177      C
178      CALL VLINE
179      C
180      VX = VX + Q1
181      VY = VY + Q2
182      VZ = VZ + Q3
183      C
184      C -----
185      C RIGHT TRAILER IMAGE
186      C -----
187      C
188      ZA = -ZA
189      ZB = -ZB
```


SUBROUTINE HSVTX

```

190 C
191
192 C      CALL VLINE
193
194      VX = VX - Q1
195      VY = VY - Q2
196      VZ = VZ - Q3
197 C
198 C      -----
199 C      DIMENSIONALIZE
200 C      -----
201
202      GDR= GAMMA/RADIUS
203      VX = VX*GDR
204      VY = VY*GDR
205      VZ = VZ*GDR
206 C
207      RETURN
208 C      END

```

SUBROUTINE HWJVEL

```

1  C
2  C
3  SUBROUTINE HWJVEL (H, UN, UMB, RVZ, RADIUS, WSPD, DELH, HMAX,
4  * HUMTYP, DXO, BDLAYM)
5  C
6  C *****
7  C SUBROUTINE HWJVEL GENERATES THE VELOCITY PROFILE AND
8  C THE FORCES AND OVERTURNING MOMENTS FOR A HUMAN BEING
9  C AT A GIVEN RADIUS
10 C *****
11 C
12 CHARACTER*1 ICONT(5)
13 CHARACTER*1 TEMCHAR
14 CHARACTER*1 KEY, KKEY, HUMTYP
15 CHARACTER*12 PTSFIL(4)
16 CHARACTER*50 COMM(2)
17 C
18 COMMON / CKEY/ KEY, KKEY
19 COMMON /CONSTS/ PI, RHO, FPSPKN, RHOD2, DRC
20 COMMON /INPUTC/ ICONT, COMM, PTSFIL
21 COMMON /PERSON/ QP(12), DSET
22 COMMON /PROFIL/ RJ, ZBJ, ZHJ, ZMJ, UMJ, ZB, ZH, ZM, UM, CU, CY
23 COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
24 C
25 C *****
26 C
27 ICD = 0
28 CALL HOMCLS(ICD)
29 C
30 C -----
31 C INPUT FOR DELH AND HMAX COMES FROM INPUTV STATUS MENU
32 C -----
33 C
34 DSET = DELH
35 C
36 IF(DSET.EQ.0.) DELH = HMAX
37 C
38 DELH = DELH/RADIUS
39 HMAX = HMAX/RADIUS
40 NHPTS = IFIX((HMAX - RVZ)/DELH) + 1
41 C
42 IF(DSET.EQ.0.)GOTO 50
43 IF(IOU6.NE.IOU1) WRITE(IOU6,(''1''))
44 C
45 IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1), COMM(2)
46 93 FORMAT( 10X, A50, /, 10X, A50, //)
47 C
48 WRITE(IOU6,1001)
49 1001 FORMAT( 12X, ' SUMMARY OF OVERTURNING FORCES AND MOMENTS', //,
50 1 19X, ' RADIUS', 6X, ' TOTF', 6X, ' TOTM', /,
51 2 20X, ' (FT)', 7X, ' (LB)', 5X, ' (FT-LB)', /)
52 50 CONTINUE
53 C
54 C -----
55 C WRITE OUT GRAPHICS FILE IF SWITCH IS SET BY USER
56 C -----
57 C
58 IF(IGRAPH.EQ.1)THEN
59 C
60 C -----
61 C OPEN GRAPHICS FILE AND WRITE FILE HEADER
62 C -----
63 C

```

SUBROUTINE HWJVEL

```

64      OPEN(IOUS,FILE=PTSFIL(3),STATUS='NEW',ERR=2000)
65      C
66      WRITE(IOUS,83) COMM(1),COMM(2)
67      83 FORMAT( 10X,A50,/,10X,A50,/)
68      C
69      WRITE(IOUS,80)
70      80 FORMAT( 1X,'TITLE="SINGLE ROTOR DFRC DATA"')
71      C
72      WRITE(IOUS,81)
73      81 FORMAT( 1X,'VARIABLES = DFRC,TOTF,TOTM')
74      C
75      WRITE(IOUS,88)
76      88 FORMAT( 1X,'ZONE T = "GW = xxxxx LB, WAGL = xx FT",',
77      *          ' I=x, F=POINT')
78      C
79      ENDIF
80      C
81      C -----
82      C BEGIN LOOP INCREMENTING THE RADIAL POINTS AT WHICH
83      C THE OVERTURNING MOMENT CALCULATIONS ARE MADE
84      C -----
85      C
86      DO 565 K = 1,NHPTS
87      C
88      C -----
89      C 'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
90      C OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
91      C -----
92      C
93      CALL PROPRM(H,UMB,RVZ)
94      C
95      ZETAM = ZM/ZB
96      ZETAH = ZH/ZB
97      C
98      C -----
99      C CALCULATION OF THE NON-DIMENSIONALIZED MINIMUM ALLOWED
100     C BOUNDARY LAYER THICKNESS SO THAT THE BOUNDARY LAYER CAN
101     C BE ADJUSTED IF THE ZM POSITION IS PHYSICALLY TOO LOW
102     C (BDLAYM, IN FEET, COMES FROM A MENU INPUT PARAMETER)
103     C -----
104     C
105     ZETA1 = BDLAYM/ZB
106     C
107     C -----
108     C BOUNDARY LAYER REGION EXPONENT
109     C 'AN' IS ACTUALLY '= 1.0/7.0'
110     C -----
111     C
112     AN = 0.142857142
113     C
114     C -----
115     C SHEAR LAYER REGION EXPONENT, TO MEET EDGE CONDITIONS
116     C (FROM FIGURE 7, USAAVLABS TECHNICAL REPORT 68-52, JULY 1968)
117     C -----
118     C
119     ALPW = ALOG(1.0 - 1.0/SQRT(2.0))/ALOG((ZH - ZM)/(ZB - ZM))
120     C
121     VN = UN
122     VMN = UM
123     C
124     C -----
125     C PRINT DETAILED REPORT IF DSET = 0.0 INSTEAD OF SIMPLE REPORT
126     C -----

```

SUBROUTINE HWJVEL

```

127 C
128 IF(DSET.NE.0.)GOTO 78
129 C
130 RRVZ = RVZ*RADIUS
131 RVZOUT = RRVZ + DXO
132 C
133 IF(IOUS.NE.IOUS) WRITE(IOUS, ' (''1'')')
134 C
135 IF(IOUS.EQ.6) WRITE(IOUS,93) COMM(1),COMM(2)
136 C
137 WRITE(IOUS,1000) RVZOUT
138 1000 FORMAT( 10X,'SINGLE ROTOR VELOCITY PROFILE AT RADIUS = ',
139 1 F7.1,' FT',//)
140 WRITE(IOUS,1005)
141 1005 FORMAT( 2X,'HEIGHT',5X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
142 1 'MEAN Q',4X,'PEAK Q',/,
143 2 3X,' (FT)',5X,' (FPS)',6X,' (KN)',5X,' (FPS)',6X,' (KN)',5X,
144 3 ' (PSF)',5X,' (PSF)',/)
145 78 CONTINUE
146 C
147 C -----
148 C SET UP ABILITY TO CALCULATE AT 0.5 FT.
149 C INCREMENTS UP THE VELOCITY PROFILE
150 C -----
151 C
152 DELZ = 0.5/RADIUS
153 NPTS = 12
154 C
155 DO 500 I = 1,NPTS
156 C
157 Z = DELZ*(I - 1) + (0.25/RADIUS)
158 ZETA = Z/ZB
159 C
160 IF(ZETA.LT.ZETAM.OR.ZETA.LT.ZETA1)THEN
161 C
162 C -----
163 C Z IS WITHIN BOUNDARY LAYER
164 C
165 C NOTE THAT THE BOUNDARY LAYER CALCULATIONS NOW USE
166 C THE MINIMUM THICKNESS PARAMETER AND THE PEAK TO
167 C MEAN VELOCITY PARAMETER IS THE MAXIMUM VELOCITY
168 C HEIGHT RATIO (AT ZM). ADDED MAY 1992 FOR V2.1.
169 C -----
170 C
171 VZM = 0.0
172 C
173 IF(ZETAM.GT.0.0)THEN
174 C
175 VZM = (ZETA/ZETAM)**AN
176 C
177 IF(ZETA1.GT.ZETAM)THEN
178 C
179 VZM1 = (1.0 - ((ZETA1 - ZETAM)/(1.0 - ZETAM))**ALPW)**2
180 VZM = VZM1*(ZETA/ZETA1)**AN
181 C
182 ENDIF
183 C
184 VMTOPK = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
185 C
186 IF(VMTOPK.LT.1.2) VMTOPK = 1.2
187 C
188 ENDIF
189 C

```

SUBROUTINE HWJVEL

```

190          GOTO 400
191 C
192 ENDIF
193 C
194 C -----
195 C Z IS WITHIN SHEAR LAYER
196 C
197 C THE PEAK TO MEAN VELOCITY RATIO EQUATIONS ARE
198 C SUBSTANTIALLY IMPROVED OVER THOSE USED PRIOR TO
199 C MAY 1992. EQUATIONS ARE NOW USED FOR BOTH THE
200 C MAXIMUM VELOCITY HEIGHT (ZM) AND THE 1/2 VELOCITY
201 C HEIGHT (ZH). VALUES BETWEEN ARE INTERPOLATED AND
202 C VALUES ABOVE ZH USE THE ZH RATIO*(ZETA/ZETAH).
203 C THESE 2nd ORDER EQUATION SUBSTANTIALLY IMPROVED
204 C CORRELATION WITH MODEL AND FLIGHT TEST DATA
205 C DURING THE MAY 1992 EFFORT FOR V2.1.
206 C -----
207 C
208 VZM = 0.0
209 C
210 IF(Z.LE.ZB) THEN
211 C
212 VZM = (1.0 - ((ZETA - ZETAM)/(1.0 - ZETAM))**ALPW)**2
213 C
214 IF(ZETA.GE.ZETAH) THEN
215 C
216 VMTOPK = (1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ)
217 1 *(ZETA/ZETAH)
218 C
219 IF(VMTOPK.LT.1.2) VMTOPK = 1.2
220 C
221 ELSE
222 C
223 VMPKMX = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
224 C
225 VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ
226 C
227 FRAC = (ZETA - ZETAM)/(ZETAH - ZETAM)
228 C
229 IF(ZETA1.GT.ZETAM) THEN
230 C
231 FRAC = (ZETA - ZETA1)/(ZETAH - ZETA1)
232 C
233 ENDIF
234 C
235 VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
236 C
237 IF(VMTOPK.LT.1.2) VMTOPK = 1.2
238 C
239 ENDIF
240 C
241 ENDIF
242 C
243 400 CONTINUE
244 C
245 VZN = VZM*VMN
246 C
247 C -----
248 C DIMENSIONAL HEIGHT
249 C -----
250 C
251 ZZ = Z*RADIUS
252 C

```

SUBROUTINE HWJVEL

```

253 C -----
254 C MEAN VELOCITIES
255 C -----
256 C
257 C VMF = VZN*VN
258 C VMK = VMF/FPSPKN
259 C
260 C -----
261 C PEAK VELOCITIES
262 C -----
263 C
264 C VPF = VMF*VMTOPK
265 C VPK = VPF/FPSPKN
266 C
267 C -----
268 C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
269 C (UPWIND SIDE) 'XKW' TIMES THE AMBIENT WIND VELOCITY TO
270 C THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
271 C -----
272 C
273 C XKW = (-0.5*H) + 2.5
274 C
275 C IF(XKW.LT.1.0) XKW = 1.0
276 C
277 C WSPD2 = WSPD*XKW
278 C VMK = VMK + WSPD2
279 C VMF = VMK*FPSPKN
280 C VPK = VPK + WSPD2
281 C VPF = VPK*FPSPKN
282 C
283 C -----
284 C DYNAMIC PRESSURE
285 C -----
286 C
287 C QM = RHOD2*VMF**2
288 C QP(I) = RHOD2*VPF**2
289 C
290 C IF(DSET.NE.0.)GOTO 77
291 C
292 C WRITE(IOU6,1002) ZZ,VMF,VMK,VPF,VPK,QM,QP(I)
293 1002 FORMAT( F8.2,6F10.3)
294 77 CONTINUE
295 C
296 C 500 CONTINUE
297 C
298 C IF(DSET.NE.0.)GOTO 520
299 C
300 C WRITE(IOU1,73)
301 73 FORMAT( )
302 C
303 C WRITE(IOU1,' (15X,A,$)')
304 1 ' TYPE <RETURN> TO CONTINUE '
305 C
306 C READ(IOU1,' (A1)') TEMCHAR
307 C
308 C ICD = 0
309 C CALL HOMCLS(ICD)
310 C IF(IOU6.NE.IOU1) WRITE(IOU6,' (''1'')')
311 C
312 C IF(IOU6.EQ.6) WRITE(IOU6,93) COMM(1),COMM(2)
313 C
314 C WRITE(IOU6,1007) RVZOUT
315 1007 FORMAT( 12X,'SINGLE ROTOR FORCE PROFILE AT RADIUS = ',

```

SUBROUTINE HWJVEL

```

316      1      F7.1,' FT',/)
317 C
318      WRITE(IOUS,1008)
319      1008 FORMAT( 2X,'HEIGHT',6X,'PEAK Q',6X,'FOVER',7X,'OVERM',7X,
320      1      'TOT F',7X,'TOT M',/,
321      2      3X,' (FT)',8X,' (PSF)',7X,' (LB)',6X,' (FT-LB)',7X,
322      3      '(LB)',6X,' (FT-LB)',/)
323 C
324      520 CONTINUE
325 C
326 C      -----
327 C      CALL SUBROUTINE TO CALCULATE THE
328 C      FORCES AND MOMENTS ON A HUMAN BEING
329 C      -----
330 C
331      CALL MOMENT(NPTS,HUMTYP,TOTF,TOTM)
332 C
333      IF(DSET.EQ.0.)GOTO 545
334 C
335      HH      = RVZ*RADIUS
336      HHOUT = HH + DXO
337 C
338      WRITE(IOUS,1014) HHOUT,TOTF,TOTM
339      1014 FORMAT( 18X,F8.2,2F10.3)
340 C
341      IF(IGRAPH.EQ.1)THEN
342 C
343          WRITE(IOUS,90) HHOUT,TOTF,TOTM
344      90      FORMAT( 1X,F7.2,1X,F7.2,1X,F8.2)
345 C
346      ENDIF
347 C
348      545 CONTINUE
349 C
350      RVZ = RVZ + DELH
351 C
352      565 CONTINUE
353 C
354 C      -----
355 C      CLOSE AN OPEN GRAPHICS FILE
356 C      -----
357 C
358      IF(IGRAPH.EQ.1)THEN
359 C
360          CLOSE(IOUS,STATUS='KEEP')
361 C
362      ENDIF
363 C
364      CALL INKEY
365 C
366      GOTO 999
367 C
368 C      -----
369 C      THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
370 C      OPEN ERRORS BY RETURNING THE USER TO A MENU
371 C      -----
372 C
373      2000 CONTINUE
374 C
375      CALL HOMCLS(0)
376      WRITE(IOUS,2001)
377      2001 FORMAT( //,,,8X,
378      1      ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',

```

SUBROUTINE HWJVEL

```
379      2 ///,8X,'      TYPE <RETURN> TO CONTINUE ', $)
380      READ(10U1,'(A1)') TEMCHAR
381      KEY = 'P'
382  C
383      999 CONTINUE
384  C
385      RETURN
386      END
387  C
388
```


SUBROUTINE INKEY

```

1  C
2  C
3  SUBROUTINE INKEY
4  C
5  C *****
6  C SUBROUTINE INKEY
7  C *****
8  C
9  C PARAMETER (NUM = 8)
10 C
11 C CHARACTER*1 KEY, KKEY
12 C CHARACTER*1 OKLIST (NUM)
13 C
14 C COMMON / CKEY/ KEY, KKEY
15 C COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
16 C *****
17 C
18 C DATA OKLIST / 'C', 'c', 'P', 'p', 'N', 'n', 'X', 'x' /
19 C
20 C -----
21 C INQUIRE, OBTAIN, AND CHECK FOR VALID MENU OPTION
22 C -----
23 C
24 C
25 10 CONTINUE
26 C
27 C WRITE (IOU1, 20)
28 20 FORMAT ( //, 7X, ' TYPE <C>CONTINUE, NEXT <P>OINT, <N>EW CASE.'
29 1 ' E<X>IT --> ', $)
30 C READ (IOU1, '(A1)') KEY
31 C
32 C IF (LEGAL (KEY, IOU1, OKLIST, NUM) .EQ. 1) GOTO 10
33 C
34 C -----
35 C CORRECT LOWER CASE LETTERS TO UPPER CASE
36 C TO USE AS VALID FLAGS IN PARENT SUBROUTINE
37 C -----
38 C
39 C IF (KEY.EQ. 'c') KEY = 'C'
40 C IF (KEY.EQ. 'p') KEY = 'P'
41 C IF (KEY.EQ. 'n') KEY = 'N'
42 C IF (KEY.EQ. 'x') KEY = 'X'
43 C
44 C -----
45 C CLEAR SCREEN AND HOME CURSOR
46 C -----
47 C
48 C ICD = 0
49 C CALL HOMCLS (ICD)
50 C
51 C RETURN
52 C END
53 C

```

SUBROUTINE INPUT

```

1  C
2  C
3  SUBROUTINE INPUT
4  C
5  C *****
6  C SUBROUTINE INPUT
7  C
8  C THIS SUBROUTINE PRESENTS THE INPUT STATUS MENU
9  C AND MANIPULUTES THE DATA FOR PROGRAM USE
10 C *****
11 C
12 C PARAMETER(NUM1 = 19)
13 C PARAMETER(NUM2 = 9)
14 C PARAMETER(NUM3 = 4)
15 C PARAMETER(NUM4 = 4)
16 C
17 C CHARACTER*1 CHDOL
18 C CHARACTER*1 CENTRY
19 C CHARACTER*1 OKLST1(NUM1)
20 C CHARACTER*1 OKLST2(NUM2)
21 C CHARACTER*1 OKLST3(NUM3)
22 C CHARACTER*1 OKLST4(NUM4)
23 C CHARACTER*1 ICONT(5)
24 C
25 C CHARACTER*12 PTSFIL(4)
26 C
27 C CHARACTER*50 COMM(2), LENTRY
28 C CHARACTER*50 PROMPT
29 C
30 C DIMENSION CONT(9), CONTV(7), CONTX(8)
31 C
32 C COMMON /INPUTC/ ICONT, COMM, PTSFIL
33 C COMMON /INPUTD/ CONT, CONTV, CONTX, YBDLAY
34 C COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
35 C
36 C *****
37 C
38 C -----
39 C SET DATA TO CHECK FOR ILLEGAL DATA INPUT
40 C -----
41 C
42 C DATA OKLST1 / ' ','A','a','B','b','C','c','D','d',
43 C 1 'E','e','F','f','G','g','H','h','I','i' /
44 C DATA OKLST2 / ' ','A','a','B','b','C','c','D','d' /
45 C DATA OKLST3 / 'V','v','H','h' /
46 C DATA OKLST4 / 'Y','y','N','n' /
47 C
48 C 10 CONTINUE
49 C
50 C -----
51 C CLEAR SCREEN AND HOME CURSOR
52 C -----
53 C
54 C CALL HOMCLS(0)
55 C CALL LOCATE(2,1)
56 C
57 C -----
58 C WRITE FIRST ENGINEERING DATA MENU
59 C -----
60 C
61 C IROTOR = IFIX(CONT(1))
62 C
63 C WRITE(IOU1, '(24X,A/)' ) ' ROTWASH USER INPUT DATA MENU'

```

SUBROUTINE INPUT

```

64      WRITE(10U1,'(T7,A,T25,A,T51,A,T61,A/))' ' CODE',' PARAMETER',
65      1 ' VALUE',' UNITS'
66      WRITE(10U1,'(8X,A,T50,I5,8X,A)')
67      1 ' A      NUMBER OF ROTORS (1 OR 2)  ',IROTOR,'-ND-'
68      WRITE(10U1,'(8X,A,T50,F8.1,6X,A)')
69      1 ' B      HUB TO HUB ROTOR SEPARATION',CONT(2),' FT'
70      WRITE(10U1,'(8X,A,T50,F8.1,6X,A)')
71      1 ' C      ROTOR RADIUS                ',CONT(3),' FT'
72      WRITE(10U1,'(8X,A,T50,F8.1,6X,A)')
73      1 ' D      GROSS WEIGHT                ',CONT(4),' LB'
74      WRITE(10U1,'(8X,A,T50,F8.1,6X,A)')
75      1 ' E      FUSELAGE DOWNLOAD FACTOR    ',CONT(5),' PCT'
76      WRITE(10U1,'(8X,A,T50,F8.1,6X,A)')
77      1 ' F      ROTOR HEIGHT ABOVE GROUND  ',CONT(6),' FT'
78      WRITE(10U1,'(8X,A,T50,F8.1,6X,A)')
79      1 ' G      SHAFT TILT ANGLE (<20 DEG) ',CONT(7),' DEG'
80      WRITE(10U1,'(8X,A,T50,F8.4,6X,A)')
81      1 ' H      AIR DENSITY RATIO          ',CONT(8),' ND'
82      WRITE(10U1,'(8X,A,T50,F8.1,6X,A//)')
83      1 ' I      AMBIENT WIND (-10 TO 10 KT)',CONT(9),' KT'
84      C
85      C
86      C  -----
87      C  PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
88      C  -----
89      20 WRITE(10U1,'(8X,A,$)')
90      1 ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
91      C
92      READ(10U1,'(A1)') CHDOL
93      C
94      IF (LEGAL(CHDOL,10U1,OKLST1,NUM1).EQ.1) GOTO 20
95      C
96      IF (CHDOL.EQ.' ') GOTO 30
97      C
98      IF (CHDOL.EQ.' A' .OR. CHDOL.EQ.' a') THEN
99      C
100         PROMPT = ' ROTORS = '
101         CALL IREAD(10U1,PROMPT,IROTOR)
102      C
103         IF (IROTOR.LT.1) IROTOR = 1
104         IF (IROTOR.GT.2) IROTOR = 2
105         CONT(1) = FLCAT(IROTOR)
106      C
107         GOTO 10
108      C
109      ENDIF
110      C
111      IF (CHDOL.EQ.' B' .OR. CHDOL.EQ.' b') THEN
112      C
113         PROMPT = ' ROTOR SEPARATION = '
114         CALL FREAD(10U1,PROMPT,CONT(2),1.0)
115         GOTO 10
116      C
117      ENDIF
118      C
119      IF (CHDOL.EQ.' C' .OR. CHDOL.EQ.' c') THEN
120      C
121         PROMPT = ' ROTOR RADIUS = '
122         CALL FREAD(10U1,PROMPT,CONT(3),1.0)
123         GOTO 10
124      C
125      ENDIF
126      C

```

SUBROUTINE INPUT

```

127      IF(CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
128  C
129          PROMPT = 'GROSS WEIGHT = '
130          CALL FREAD(IOU1,PROMPT,CONT(4),1.0)
131          GOTO 10
132  C
133      ENDIF
134  C
135      IF(CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
136  C
137          PROMPT = 'DOWNLOAD FACTOR = '
138          CALL FREAD(IOU1,PROMPT,CONT(5),1.0)
139          GOTO 10
140  C
141      ENDIF
142  C
143      IF(CHDOL.EQ.'F'.OR.CHDOL.EQ.'f') THEN
144  C
145          PROMPT = 'HEIGHT ABOVE GROUND = '
146          CALL FREAD(IOU1,PROMPT,CONT(6),1.0)
147          GOTO 10
148  C
149      ENDIF
150  C
151      IF(CHDOL.EQ.'G'.OR.CHDOL.EQ.'g') THEN
152  C
153          PROMPT = 'SHAFT TILT = '
154          CALL FREAD(IOU1,PROMPT,CONT(7),1.0)
155  C
156          IF(CONT(7).LT. 0.0) CONT(7) = 0.0
157          IF(CONT(7).GT.20.0) CONT(7) = 20.0
158          GOTO 10
159  C
160      ENDIF
161  C
162      IF(CHDOL.EQ.'H'.OR.CHDOL.EQ.'h') THEN
163  C
164          PROMPT = 'DENSITY RATIO = '
165          CALL FREAD(IOU1,PROMPT,CONT(8),1.0)
166          GOTO 10
167  C
168      ENDIF
169  C
170      IF(CHDOL.EQ.'I'.OR.CHDOL.EQ.'i') THEN
171  C
172          PROMPT = 'WIND VELOCITY = '
173          CALL FREAD(IOU1,PROMPT,CONT(9),1.0)
174  C
175          IF(CONT(9).LT.-10.0) CONT(9) = -10.0
176          IF(CONT(9).GT. 10.0) CONT(9) = 10.0
177          GOTO 10
178  C
179      ENDIF
180  C
181          GOTO 10
182  C
183      30 CONTINUE
184  C
185      -----
186      CLEAR SCREEN AND HOME CURSOR
187      -----
188  C
189      CALL HOMCLS(0)

```

SUBROUTINE INPUT

```

190      CALL LOCATE(2,1)
191      C
192      C -----
193      C WRITE SECOND ENGINEERING DATA MENU
194      C -----
195      C
196      WRITE(IOU1,40)
197      40 FORMAT(' ',18X,' ROTWASH PROGRAM LOGIC/COMMENT MENU',/,/,
198      1      10X,'CODE'           PARAMETER           VALUE'/)
199      C
200      WRITE(IOU1,50) ICONT(1),ICONT(2),COMM(1),COMM(2)
201      50 FORMAT(12X,'A'           ANALYSIS TYPE,      <V> OR <H>',5X,A4,/,
202      1      12X,'B'           GRAPHICS FILE,        <Y> OR <N>',5X,A4,///,
203      2      15X,'USER INPUT COMMENTS (FOR "PRN" AND "PLT" OUTPUT)',
204      3      //,17X,'<---'           50 SPACES           --->',
205      4      /,12X,'C',4X,A50,/,
206      5      12X,'D',4X,A50,/)
207      C
208      C -----
209      C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
210      C -----
211      C
212      60 WRITE(IOU1,' (8X,A,$)')
213      1' ENTER CODE FOR DATA INPUT OR <RETURN> TO CONTINUE ==> '
214      C
215      READ(IOU1,'(A1)') CHDOL
216      C
217      IF(LEGAL(CHDOL,IOU1,OKLST2,NUM2).EQ.1)GOTO 60
218      C
219      IF(CHDOL.EQ.' ')GOTO 70
220      C
221      C -----
222      C CHOOSE VELOCITY OR HAZARD ANALYSIS OPTION
223      C -----
224      C
225      IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a') THEN
226      C
227      80 CONTINUE
228      C
229      WRITE(IOU1,'(/,35X,A,1X,A2/)') ' ANALYSIS TYPE = ',ICONT(1)
230      WRITE(IOU1,'(40X,A,$)') ' ENTER NEW VALUE ==> '
231      READ(IOU1,'(A1)') CENTRY
232      C
233      IF(LEGAL(CENTRY,IOU1,OKLST3,NUM3).EQ.1)GOTO 80
234      C
235      ICONT(1) = CENTRY
236      IF(ICONT(1).EQ.'v') ICONT(1) = 'V'
237      IF(ICONT(1).EQ.'h') ICONT(1) = 'H'
238      GOTO 30
239      C
240      ENDIF
241      C
242      C -----
243      C CHOOSE OUTPUT TO A GRAPHICS FILE OR NOT
244      C -----
245      C
246      IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b') THEN
247      C
248      90 CONTINUE
249      C
250      WRITE(IOU1,'(/,35X,A,1X,A2/)') ' GRAPHICS FLAG = ',ICONT(2)
251      WRITE(IOU1,'(40X,A,$)') ' ENTER NEW VALUE ==> '
252      READ(IOU1,'(A1)') CENTRY

```

SUBROUTINE INPUT

```

253 C
254 IF (LEGAL(CENTRY, IOU1, OKLST4, NUM4) .EQ. 1) GOTO 90
255 C
256 ICONT(2) = CENTRY
257 IF (ICONT(2) .EQ. 'Y') ICONT(2) = 'Y'
258 IF (ICONT(2) .EQ. 'N') ICONT(2) = 'N'
259 IF (ICONT(2) .EQ. 'Y') IGRAPH = 1
260 IF (ICONT(2) .EQ. 'N') IGRAPH = 0
261 GOTO 30
262 C
263 ENDIF
264 C
265 C -----
266 C CHOOSE COMMENT STRINGS FOR OUTPUT DATA
267 C -----
268 C
269 IF (CHDOL.EQ. 'C' .OR. CHDOL.EQ. 'c') THEN
270 C
271 WRITE(IOU1, '(/, 5X, A, A50/)') ' COMMENT STRING = ', COMM(1)
272 WRITE(IOU1, '(5X, A, $)') ' ENTER STRING ==> '
273 READ(IOU1, '(A50)') LENTRY
274 C
275 COMM(1) = LENTRY
276 GOTO 30
277 C
278 ENDIF
279 C
280 IF (CHDOL.EQ. 'D' .OR. CHDOL.EQ. 'd') THEN
281 C
282 WRITE(IOU1, '(/, 5X, A, A50/)') ' COMMENT STRING = ', COMM(2)
283 WRITE(IOU1, '(5X, A, $)') ' ENTER STRING ==> '
284 READ(IOU1, '(A50)') LENTRY
285 C
286 COMM(2) = LENTRY
287 GOTO 30
288 C
289 ENDIF
290 C
291 GOTO 30
292 C
293 70 CONTINUE
294 C
295 RETURN
296 END
297 C

```

SUBROUTINE INPUTV

```

1  C
2  C
3  SUBROUTINE INPUTV(FLOW)
4  C
5  C *****
6  C SUBROUTINE INPUTV
7  C
8  C THIS SUBROUTINE PRESENTS THE INPUT STATUS MENU AND MANIPULATES
9  C DATA FOR THE WALJET AND IPLANE PROGRAM OPTIONS
10 C *****
11 C
12 C PARAMETER(NUM = 11)
13 C
14 C CHARACTER*1 OKLIST(NUM)
15 C CHARACTER*1 CHDOL, FLOW
16 C CHARACTER*1 ICONT(5)
17 C CHARACTER*12 TMPFIL
18 C CHARACTER*12 PTSFIL(4)
19 C CHARACTER*50 COMM(2)
20 C CHARACTER*50 PROMPT
21 C
22 C DIMENSION CONT(9), CONTV(7), CONTX(8)
23 C
24 C COMMON /INPUTC/ ICONT, COMM, PTSFIL
25 C COMMON /INPUTD/ CONT, CONTV, CONTX, YBDLAY
26 C COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
27 C
28 C *****
29 C
30 C DATA OKLIST / ' ', 'A', 'a', 'B', 'b', 'C', 'c', 'D', 'd', 'E', 'e' /
31 C
32 C -----
33 C CLEAR SCREEN AND HOME CURSOR
34 C -----
35 C
36 C ICD = 0
37 C
38 C 20 CONTINUE
39 C
40 C CALL HOMCLS(ICD)
41 C CALL LOCATE(1,1)
42 C
43 C WRITE(IOU1,12)
44 C 12 FORMAT( 22X, ' VELOCITY PROFILE STATUS MENU', ///,
45 C 1 10X, 'CODE' PARAMETER VALUE',
46 C 2 3X, 'UNITS', /)
47 C
48 C -----
49 C PRINT OUT MENU VARIABLES AS BASED ON THE WALL JET
50 C OPTION OR INTERACTION PLANE OPTION SWITCH SETTING
51 C -----
52 C
53 C IF(FLOW.EQ.'W') THEN
54 C
55 C WRITE(IOU1,14) (CONTV(I), I=1, 3), YBDLAY, PTSFIL(1)
56 C
57 C ELSE
58 C
59 C WRITE(IOU1,14) (CON... (I), I=1, 3), YBDLAY, PTSFIL(2)
60 C
61 C ENDIF
62 C
63 C 14 FORMAT( 12X, 'A PROFILE STATION POSITION ', 5X, F7.2,

```

SUBROUTINE INPUTV

```

64      1  4X,'FT',/,
65      2 12X,'B'  VERTICAL INCREMENT      ',4X,F7.2,4X,'FT',/,
66      3 12X,'C'  MAXIMUM PROFILE HEIGHT   ',4X,F7.2,4X,'FT',/,
67      4 12X,'D'  MINIMUM BOUNDARY LAYER
68 HEIGHT',1X,F7.2,4X,'FT',/,
69      5 12X,'E'  DATA OUTPUT FILENAME    ',7X,A12,/)
70 C
71 C -----
72 C PROMPT FOR, OBTAIN, AND CHECK FOR LEGAL INPUT DATA
73 C -----
74 C
75 10 CONTINUE
76 C
77 WRITE(IOU1,'(8X,A,$)')
78 1 ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
79 C
80 READ(IOU1,'(A1)') CHDOL
81 C
82 IF(LEGAL(CHDOL,IOU1,OKLIST,NUM).EQ.1)GOTO 10
83 C
84 IF(CHDOL.EQ.' ')GOTO 30
85 C
86 IF(CHDOL.EQ.'A'.OR.CHDOL.EQ.'a')THEN
87 C
88     PROMPT = 'PROFILE STATION POSITION = '
89     CALL FREAD(IOU1,PROMPT,CONTV(1),1.0)
90 C
91     IF(CONTV(1).LT.0.0) CONTV(1) = 0.0
92     GOTO 20
93 C
94 ENDIF
95 C
96 IF(CHDOL.EQ.'B'.OR.CHDOL.EQ.'b')THEN
97 C
98     PROMPT = 'VERTICAL INCREMENT = '
99     CALL FREAD(IOU1,PROMPT,CONTV(2),1.0)
100 C
101     IF(CONTV(2).LT.0.0) CONTV(2) = 0.0
102     GOTO 20
103 C
104 ENDIF
105 C
106 IF(CHDOL.EQ.'C'.OR.CHDOL.EQ.'c')THEN
107 C
108     PROMPT = 'MAXIMUM PROFILE HEIGHT = '
109     CALL FREAD(IOU1,PROMPT,CONTV(3),1.0)
110 C
111     IF(CONTV(3).LT.0.0) CONTV(3) = 0.0
112     GOTO 20
113 C
114 ENDIF
115 C
116 IF(CHDOL.EQ.'D'.OR.CHDOL.EQ.'d')THEN
117 C
118     PROMPT = 'MINIMUM BOUNDARY LAYER HEIGHT = '
119     CALL FREAD(IOU1,PROMPT,YBDLAY,1.0)
120 C
121     IF(YBDLAY.LT.0.0) YBDLAY = 0.0
122     GOTO 20
123 C
124 ENDIF
125 C
126 C -----

```


SUBROUTINE INPUTV

```

127 C    CHOOSE GRAPHICS FILENAME
128 C    -----
129 C
130 C    IF (CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
131 C
132 C        IF (FLOW.EQ.'W') THEN
133 C            WRITE(IOU1,'(/,25X,A,1X,A12/)')
134 C            1 ' FILENAME = ',PTSFIL(1)
135 C        ELSE
136 C            WRITE(IOU1,'(/,25X,A,1X,A12/)')
137 C            1 ' FILENAME = ',PTSFIL(2)
138 C        ENDIF
139 C
140 C        WRITE(IOU1,'(20X,A,$)')
141 C        1 ' ENTER NEW FILENAME (xxxxxxxx.xxx) ==> '
142 C
143 C        READ(IOU1,'(A12)') TMPFIL
144 C
145 C        IF (FLOW.EQ.'W') PTSFIL(1) = TMPFIL
146 C        IF (FLOW.EQ.'I') PTSFIL(2) = TMPFIL
147 C        GOTO 20
148 C
149 C    ENDIF
150 C
151 C    GOTO 20
152 C
153 C    30 CONTINUE
154 C
155 C    ICD = 0
156 C    CALL HOMCLS(ICD)
157 C
158 C    RETURN
159 C    END
160 C

```

SUBROUTINE INPUTX

```

1  C
2  C
3  SUBROUTINE INPUTX
4  C
5  C *****
6  C SUBROUTINE INPUTX PRESENTS THE INPUT STATUS MENU AND
7  C MANIPULATES DATA FOR PROGRAM USE WITH THE GROUND AND
8  C DISC VORTEX OPTIONS
9  C *****
10 C
11 C PARAMETER(NUM = 15)
12 C
13 C CHARACTER*1 OKLIST(NUM)
14 C CHARACTER*1 CHDOL
15 C CHARACTER*1 ICONT(5)
16 C CHARACTER*12 PTSFIL(4)
17 C CHARACTER*50 COMM(2)
18 C CHARACTER*50 PROMPT
19 C
20 C DIMENSION CONT(9),CONTV(7),CONTX(8)
21 C
22 C COMMON /INPUTC/ ICONT,COMM,PTSFIL
23 C COMMON /INPUTD/ CONT,CONTV,CONTX,YBDLAY
24 C COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
25 C
26 C *****
27 C
28 C DATA OKLIST / ' ','A','a','B','b','C','c','D','d',
29 C 1 'E','e','F','f','G','g'/
30 C
31 C -----
32 C CLEAR SCREEN AND HOME CURSOR
33 C -----
34 C
35 C ICD = 0
36 C
37 C 20 CONTINUE
38 C
39 C CALL HOMCLS(ICD)
40 C CALL LOCATE(1,1)
41 C
42 C WRITE(IOU1,10)
43 C 10 FORMAT( 18X,' GROUND/DISK VORTEX INPUT DATA MENU',/,
44 C 1 15X,' (FOR SINGLE MAIN ROTOR HELICOPTERS ONLY)',/,/,
45 C 1 8X,'CODE' PARAMETER VALUE',
46 C 2 4X,'UNITS',/,)
47 C
48 C WRITE(IOU1,11) (CONTX(I),I=1,7)
49 C 11 FORMAT( 10X,'A ROTOR TIP SPEED ',5X,F8.2,
50 C 1 4X,'FPS',/,
51 C 2 10X,'B NUMBER OF ROTOR BLADES ',5X,F8.2,4X,'-ND-',/,
52 C 3 10X,'C TRANSLATIONAL SPEED ',5X,F8.2,4X,'KTS',/,
53 C 4 10X,'D XT POSITION ',5X,F8.2,4X,'FT',/,
54 C 5 10X,'E YT POSITION ',5X,F8.2,4X,'FT',/,
55 C 6 10X,'F ZT CALCULATION INCREMENT ',5X,F8.2,4X,'FT',/,
56 C 7 10X,'G MAXIMUM CALCULATION HEIGHT',5X,F8.2,4X,'FT',/,/)
57 C
58 C -----
59 C INQUIRE, OBTAIN, AND CHECK FOR VALID MENU OPTION
60 C -----
61 C
62 C 40 CONTINUE
63 C

```

SUBROUTINE INPUTX

```

64      WRITE(IOU1,'(8X,A,$)')
65      1 ' ENTER DATA ENTRY CODE OR <RETURN> TO CONTINUE ==> '
66      C
67      READ(IOU1,'(A1)') CHDOL
68      C
69      IF (LEGAL(CHDOL,IOU1,OKLIST,NUM).EQ.1) GOTO 40
70      C
71      IF (CHDOL.EQ.' ') GOTO 30
72      C
73      IF (CHDOL.EQ.'A'.OR.CHDOL.EQ.'a') THEN
74      C
75          PROMPT = 'ROTOR TIP SPEED = '
76          CALL FREAD(IOU1,PROMPT,CONTX(1),1.0)
77      C
78          IF (CONTX(1).LT.0.0) CONTX(1) = 0.0
79          GOTO 20
80      C
81      ENDIF
82      C
83      IF (CHDOL.EQ.'B'.OR.CHDOL.EQ.'b') THEN
84      C
85          PROMPT = 'NUMBER OF ROTOR BLADES = '
86          CALL FREAD(IOU1,PROMPT,CONTX(2),1.0)
87      C
88          IF (CONTX(2).LT.2.0) CONTX(2) = 2.0
89          GOTO 20
90      C
91      ENDIF
92      C
93      IF (CHDOL.EQ.'C'.OR.CHDOL.EQ.'c') THEN
94      C
95          PROMPT = 'TRANSLATIONAL SPEED = '
96          CALL FREAD(IOU1,PROMPT,CONTX(3),1.0)
97      C
98          IF (CONTX(3).LT.0.0) CONTX(3) = 0.0
99          GOTO 20
100     C
101     ENDIF
102     C
103     IF (CHDOL.EQ.'D'.OR.CHDOL.EQ.'d') THEN
104     C
105         PROMPT = 'XT POSITION = '
106         CALL FREAD(IOU1,PROMPT,CONTX(4),1.0)
107         GOTO 20
108     C
109     ENDIF
110     C
111     IF (CHDOL.EQ.'E'.OR.CHDOL.EQ.'e') THEN
112     C
113         PROMPT = 'YT POSITION = '
114         CALL FREAD(IOU1,PROMPT,CONTX(5),1.0)
115         GOTO 20
116     C
117     ENDIF
118     C
119     IF (CHDOL.EQ.'F'.OR.CHDOL.EQ.'f') THEN
120     C
121         PROMPT = 'ZT CALCULATION INCREMENT = '
122         CALL FREAD(IOU1,PROMPT,CONTX(6),1.0)
123     C
124         IF (CONTX(6).LT.0.0) CONTX(6) = 0.0
125         GOTO 20
126     C

```

SUBROUTINE INPUTX

```
127      ENDIF
128      C
129      IF (CHDOL.EQ.'G'.OR.CHDOL.EQ.'g') THEN
130      C
131          PROMPT = 'MAXIMUM CALCULATION HEIGHT = '
132          CALL FREAD(IOU1,PROMPT,CONTX(7),1.0)
133      C
134          IF (CONTX(7).LT.0.0) CONTX(7) = 0.0
135          GOTO 20
136      C
137      ENDIF
138      C
139      GOTO 20
140      C
141      30 CONTINUE
142      C
143          ICD = 0
144          CALL HOMCLS(ICD)
145      C
146          RETURN
147          END
148      C
149
```

SUBROUTINE IOFNSH

```

1  C
2  C
3  SUBROUTINE IOFNSH
4  C
5  C *****
6  C SUBROUTINE IOFNSH CLOSES FILES OPENED FOR DISK I/O
7  C *****
8  C
9  COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
10 C
11 C *****
12 C
13 C -----
14 C KEEP STANDARD I/O FILES IF ON DISK, ELSE DELETE
15 C -----
16 C
17 IF (IOU5.EQ.5) CLOSE(IOU5,STATUS='KEEP')
18 IF (IOU6.EQ.6) CLOSE(IOU6,STATUS='KEEP')
19 C
20 RETURN
21 END
22 C

```

SUBROUTINE IOINIT

```

1  C
2  C
3  SUBROUTINE IOINIT
4  C
5  C *****
6  C SUBROUTINE IOINIT DISPLAYS THE OPENING BANNER
7  C AND OPENS THE FILES FOR DISK I/O, FILENAMES
8  C ARE PROMPTED FROM THE TERMINAL
9  C *****
10 C
11 CHARACTER*3 IPFILE,OPFILE
12 CHARACTER*1 TEMCHAR
13 C
14 COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
15 C
16 C *****
17 C
18 C -----
19 C ASSIGN DEFAULT VALUES TO I/O UNIT POINTERS
20 C -----
21 C
22 IOU1   = 0
23 IOU4   = 0
24 IOU5   = 0
25 IOU6   = 6
26 IOU7   = 0
27 IOU8   = 8
28 IGRAPH = 0
29 C
30 C -----
31 C HOME CURSOR AND CLEAR THE DISPLAY
32 C -----
33 C
34 ICD = 0
35 CALL HOMCLS(ICD)
36 C
37 C -----
38 C DISPLAY BANNER
39 C -----
40 C
41 CALL LOCATE(5,1)
42 C
43 C -----
44 C ORIGINAL ROTHAZ PROGRAM WAS VERSION 1.0
45 C FIRST VAX MENU VERSION OF ROTHAZ WAS VERSION 1.1
46 C PROGRAM ROTWASH REPLACES ROTHAZ AT VERSION 2.0
47 C -----
48 C
49 WRITE(IOU1,10)
50 10 FORMAT( 27X,'ROTWASH PROGRAM',//
51 1 //,17X,'ROTORCRAFT DOWNWASH HAZARD ANALYSIS',/
52 2 //,18X,'EMA / SYSTEMS CONTROL TECHNOLOGY',
53 3 //,15X,'*** PROGRAM VERSION 2.1, APRIL 1993 ***'
54 4 //)
55 C
56 WRITE(IOU1,' (A,$)')
57 1 ' PRESS <RETURN>
58 READ(IOU1,' (A1)') TEMCHAR
59 C
60 C -----
61 C HOME CURSOR AND CLEAR THE DISPLAY
62 C -----
63 C

```

SUBROUTINE IOINIT

```

64      ICD = 0
65      CALL HOMCLS(ICD)
66      CALL LOCATE(3,1)
67      C
68      C -----
69      C PROMPT FOR I/O FILES AND READ USER RESPONSE
70      C -----
71      C
72      WRITE(IOU1,12)
73      12 FORMAT( 14X,' I/O CAN BE DIRECTED TO FILES OR DEVICES',/,/,
74      1      19X,' VALID DEVICES ARE AS FOLLOWS:',/,/,
75      2      22X,' <CON> ==> CONSOLE',/,/,
76      2      22X,' <PRN> ==> PRINTER',/,/,
77      4      22X,' <PLT> ==> GRAPHICS FILE',/,/,)
78      C
79      16 CONTINUE
80      C
81      WRITE(IOU1,13)
82      13 FORMAT( 16X,' ENTER INPUT FILE/DEV NAME ==> ',$,)
83      11 FORMAT(A)
84      READ(IOU1,11) IPFILE
85      C
86      C -----
87      C CHECK FOR DATA ENTRY ERROR
88      C -----
89      C
90      IF(IPFILE.NE.'CON'.AND.IPFILE.NE.'con') THEN
91      WRITE(IOU1,15)
92      15 FORMAT(/,16X,' ** INPUT ERROR, PLEASE REENTER **',/,/)
93      GOTO 16
94      ENDIF
95      C
96      17 CONTINUE
97      C
98      WRITE(IOU1,14)
99      14 FORMAT( 16X,' ENTER OUTPUT FILE/DEV NAME ==> ',$,)
100     READ(IOU1,11) OPFILE
101     C
102     C -----
103     C CHECK FOR DATA ENTRY ERROR
104     C -----
105     C
106     IF(OPFILE.NE.'CON'.AND.OPFILE.NE.'con'.AND.
107     1 OPFILE.NE.'PRN'.AND.OPFILE.NE.'prn'.AND.
108     2 OPFILE.NE.'PLT'.AND.OPFILE.NE.'plt') THEN
109     WRITE(IOU1,15)
110     GOTO 17
111     ENDIF
112     C
113     C -----
114     C REDIRECT INPUT/OUTPUT FILES IF REQUESTED
115     C -----
116     C
117     IF(IPFILE.EQ.'CON'.OR.IPFILE.EQ.'con') IOU5 = IOU1
118     IF(OPFILE.EQ.'CON'.OR.OPFILE.EQ.'con') IOU6 = IOU1
119     IF(OPFILE.EQ.'PRN'.OR.OPFILE.EQ.'prn') IOU6 = 6
120     C
121     IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt') IGRAPH = 1
122     IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt') IOU6 = IOU1
123     IF(OPFILE.EQ.'PLT'.OR.OPFILE.EQ.'plt') IOU8 = 8
124     C
125     C -----
126     C OPEN STANDARD I/O FILES

```

SUBROUTINE IOINIT

```

127 C
128 C      IOU5 = STD. INPUT
129 C      IOU6 = STD. OUTPUT
130 C      -----
131 C
132 C      IF (IOU5.EQ.5) OPEN(IOU5,FILE=IPFILE,STATUS='OLD')
133 C      IF (IOU6.EQ.6) OPEN(IOU6,FILE=OPFILE,STATUS='NEW')
134 C
135 C      -----
136 C      HOME CURSOR AND CLEAR THE DISPLAY
137 C      -----
138 C
139 C      ICD = 0
140 C      CALL HOMCLS(ICD)
141 C
142 C      RETURN
143 C      END
144 C

```


SUBROUTINE IPVEL

```

1  C
2  C
3  SUBROUTINE IPVEL (H, UN, RADIUS, UMB, XIP, YSEP, WSPD, DELZ,
4  1      ZMAX, DXO, BDLAYM)
5  C
6  C      *****
7  C      SUBROUTINE IPVEL GENERATES THE VELOCITY PROFILE V(X,Z) AT
8  C      XVZ ALONG THE INTERACTION PLANE FOR THE TWO ROTOR CASE
9  C      *****
10 C
11 CHARACTER*1 TEMCHAR
12 CHARACTER*1 ICONT(5)
13 CHARACTER*1 KEY, KKEY
14 CHARACTER*12 PTSFIL(4)
15 CHARACTER*50 COMM(2)
16 C
17 DIMENSION ZZ(60), VHM(60), VHMK(60), VHPF(60), VHPK(60),
18 1      QHM(60), QHP(60), VVMF(60), VVMK(60), VVPF(60),
19 2      VVPK(60), QVM(60), QVP(60)
20 C
21 COMMON / CKEY/ KEY, KKEY
22 COMMON /CONSTS/ PI, RHO, FPSPKN, RHOD2, DRC
23 COMMON /INPUTC/ ICONT, COMM, PTSFIL
24 COMMON /PROFIL/ RJ, ZBJ, ZHJ, ZMJ, UMJ, ZB, ZH, ZM, UM, CU, CY
25 COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
26 C
27 C      *****
28 C
29 C      -----
30 C      TF IS THE INTERACTION PLANE AMPLIFICATION FACTOR
31 C      (ORIGINALLY DEVELOPED BY M. GEORGE IN USAAVLABS TR 68-52)
32 C
33 C      ORIGINAL EQUATION FOR TF FACTOR WAS:
34 C
35 C       $TF = 1.55 - 0.55 \cdot \exp(-1.35 \cdot XIP)$ 
36 C
37 C      REPLACED WITH MODIFIED EXPRESSION (SEE BELOW) DURING
38 C      CORRELATION EFFORT OF MAY 1992 FOR VERSION 2.1
39 C      -----
40 C
41 C       $TF = 1.65 - 0.65 \cdot \exp(-0.5 \cdot XIP)$ 
42 C
43 C      -----
44 C      OBTAIN PARAMETERS AT BASE RADIUS FOR THE 'BOUNDARY LAYER'
45 C      -----
46 C
47 C       $RIP0 = \sqrt{XIP^2 + YSEP^2}$ 
48 C
49 C      -----
50 C      'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
51 C      OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
52 C      -----
53 C
54 C      CALL PROPRM(H, UMB, RIP0)
55 C
56 C      ZIPB = ZB
57 C      ZIPM = ZM
58 C      ZIPH = ZH
59 C
60 C       $RIPM = \sqrt{XIP^2 + (YSEP + ZIPM)^2}$ 
61 C
62 C      CALL PROFKM(H, UMB, RIPM)
63 C

```

SUBROUTINE IPVEL

```

64      UMM = UM
65      C
66      C -----
67      C INCREMENT AND MAXIMUM HEIGHT ARE DELZ AND ZMAX
68      C -----
69      C
70      NPTS = IFIX(ZMAX/DELZ) + 2
71      C
72      IF(NPTS.GT.60) NPTS = 60
73      C
74      C -----
75      C DIMENSIONALIZE VELOCITY PROFILE PARAMETERS
76      C -----
77      C
78      XXIF = RADIUS*XIP
79      ZZB = ZIPB*RADIUS
80      ZZH = ZIPH*RADIUS
81      ZZM = ZIPM*RADIUS
82      C
83      C -----
84      C OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
85      C -----
86      C
87      ICD = 0
88      CALL HOMCIS(ICD)
89      C
90      IF(IOUS.NE.IOUS) WRITE(IOUS,'(''1'')')
91      C
92      IF(IOUS.EQ.6) WRITE(IOUS,93) COMM(1),COMM(2)
93      93 FORMAT( 10X,A50,/,10X,A50,/)
94      C
95      XIPOUT = XXIF + DXO
96      C
97      WRITE(IOUS,1000) XIPOUT
98      1000 FORMAT( 2X,'TWIN ROTOR INTERACTION PLANE VELOCITY PROFILE',
99      1          ' AT STATION = ',F7.1,' FT',/)
100     C
101     WRITE(IOUS,1002)
102     1002 FORMAT( 2X,'HEIGHT',8X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
103     1          'MEAN Q',4X,'PEAK Q',/,
104     2          3X,'(FT)',8X,'(FPS)',6X,'(KN)',5X,'(FPS)',6X,'(KN)',5X,
105     3          '(PSF)',5X,'(PSF)',/)
106     C
107     LINES = 0
108     C
109     C -----
110     C 'AN' IS ACTUALLY '= 1.0/7.0'
111     C -----
112     C
113     AN = 0.142857142
114     C
115     C -----
116     C CALCULATE THE VELOCITY PROFILE POINTS FOR OUTPUT
117     C 'NPTS' IS THE NUMBER OF VERTICAL STATION POINTS
118     C -----
119     C
120     DO 500 I = 1,NPTS
121     C
122         LINES = LINES + 2
123         ZIP = DELZ*FLOAT(I - 1)
124     C
125     C -----
126     C GET MAX WALL JET VELOCITY AT EFFECTIVE RADIUS

```

SUBROUTINE IPVEL

```

127 C -----
128 C
129 C RIP = SQRT(XIP**2 + (YSEP + ZIP)**2)
130 C
131 C CALL PROPRM(H,UMB,RIP)
132 C
133 C VN = UN
134 C VZ = UM
135 C
136 C -----
137 C INTERACTION PLANE 'BOUNDARY LAYER'
138 C
139 C CODE MODIFIED IN MAY 1992 FOR USER SPECIFIED
140 C MINIMUM BOUNDARY LAYER THICKNESS (BDLAYM)
141 C -----
142 C
143 C ZIP1 = BDLAYM
144 C
145 C IF(ZIP.LT.ZIPM.OR.ZIP.LT.ZIP1)THEN
146 C
147 C     IF(ZIP1.LT.ZIPM)THEN
148 C
149 C         VZ = UMM*(ZIP/ZIPM)**AN
150 C
151 C     ELSE
152 C
153 C         VZ = UMM*(ZIP/ZIP1)**AN
154 C
155 C     ENDIF
156 C
157 C ENDIF
158 C
159 C -----
160 C DEVELOPED INTERACTION PLANE JET
161 C CONTAINS BOTH HORIZONTAL AND VERTICAL VELOCITY COMPONENTS
162 C -----
163 C
164 C VH = TF*VZ*XIP/RIP
165 C VV = TF*VZ*(YSEP + ZIP)/RIP
166 C
167 C ZZ(I) = ZIP*RADIUS
168 C
169 C -----
170 C MEAN VELOCITIES (BOTH FT/SEC AND KNOTS)
171 C -----
172 C
173 C VHMF(I) = VH*UN
174 C VVMF(I) = VV*UN
175 C VHMK(I) = VHMF(I)/FPSKPN
176 C VVMK(I) = VVMF(I)/FPSKPN
177 C
178 C -----
179 C PEAK VELOCITIES (BOTH FT/SEC AND KNOTS)
180 C
181 C EQUATION FOR VMFD3I UPDATED FROM 1st TO
182 C 2nd ORDER POLYNOMIAL FOR VERSION 2.1
183 C -----
184 C
185 C VMFD3I = 0.712887 + 0.304369*XIP - 0.018496*XIP*XIP
186 C
187 C IF(VMFD3I.LT.1.2) VMFD3I = 1.2
188 C
189 C VHPF(I) = VMFD3I*VHMF(I)

```

SUBROUTINE IPVEL

```

190      VVPF(I) = VMFD3I*VVMF(I)
191      VHPK(I) = VHPF(I)/FPSPKN
192      VVPK(I) = VVPF(I)/FPSPKN
193      C
194      IF(VHMF(I).EQ.0.)GOTO 55
195      C
196      C -----
197      C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
198      C (UPWIND SIDE) 'XKW' TIMES THE AMBIENT WIND VELOCITY TO
199      C THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
200      C -----
201      C
202      XKW = (-0.5*H) + 2.5
203      C
204      IF(XKW.LT.1.0) XKW = 1.0
205      C
206      WSPD2 = WSPD*XKW
207      VHMK(I) = VHMK(I) + WSPD2
208      VVMF(I) = VVMF(I)*FPSPKN
209      VHPK(I) = VHPK(I) + WSPD2
210      VHPF(I) = VHPK(I)*FPSPKN
211      C
212      55  CONTINUE
213      C
214      C -----
215      C DYNAMIC PRESSURES
216      C -----
217      C
218      QHM(I) = RHOD2*VHMF(I)**2
219      QVM(I) = RHOD2*VVMF(I)**2
220      QHP(I) = RHOD2*VHPF(I)**2
221      QVP(I) = RHOD2*VVPF(I)**2
222      C
223      IF(IOUS.EQ.IOUS1) THEN
224      C
225          IF(LINES.LT.12)GOTO 450
226          LINES = 2
227          CALL INKEY
228          IF(KEY.NE.'C')GOTO 999
229          WRITE(IOUS,1002)
230      C
231      ENDF
232      C
233      450  CONTINUE
234      C
235      C -----
236      C REPORT HORIZONTAL COMPONENTS OF VELOCITY PROFILE
237      C -----
238      C
239      WRITE(IOUS,1003) ZZ(I),VHMF(I),VHMK(I),VHPF(I),
240      *      VHPK(I),QHM(I),QHP(I)
241      1003  FORMAT ( F8.2,2X,'H',6F10.3)
242      C
243      C -----
244      C REPORT VERTICAL COMPONENTS OF VELOCITY PROFILE
245      C -----
246      C
247      WRITE(IOUS,1004) VVMF(I),VVMK(I),VVPF(I),VVPK(I),
248      *      QVM(I),QVP(I)
249      1004  FORMAT ( 10X,'V',6F10.3)
250      C
251      500  CONTINUE
252      C

```

SUBROUTINE IPVEL

```

253 C -----
254 C WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER
255 C -----
256 C
257 C IF(IGRAPH.EQ.1) THEN
258 C
259 C -----
260 C OPEN GRAPHICS FILE
261 C -----
262 C
263 C OPEN(IOU8,FILE=PTSFIL(2),STATUS='NEW',ERR=2000)
264 C
265 C WRITE(IOU8,89) COMM(1),COMM(2)
266 89 FORMAT( 10X,A50,/,10X,A50,/)
267 C
268 C WRITE(IOU8,80) XIPOUT
269 80 FORMAT( 1X,'TITLE="VELOCITY PROFILE, DAIP =',F5.1,' FT,'
270 * ' GW = xxxxx LB, WAGL = xx.x FT"')
271 C
272 C -----
273 C PRINT OUT MEAN VELOCITY, PEAK VELOCITY, AND PEAK
274 C DYNAMIC PRESSURE PROFILES VERSUS PROFILE HEIGHT (AGL)
275 C -----
276 C
277 C WRITE(IOU8,88)
278 88 FORMAT( 1X,'VARIABLES = X,HT')
279 C
280 C WRITE(IOU8,81)
281 81 FORMAT( 1X,'ZONE T = "MEAN PROFILE, KTS", I=xx, F=POINT')
282 DO 82 I = 1,NPTS
283 WRITE(IOU8,83) VHMK(I),ZZ(I)
284 83 FORMAT( 1X,F6.1,1X,F6.2)
285 82 CONTINUE
286 C
287 C WRITE(IOU8,84)
288 84 FORMAT( 1X,'ZONE T = "PEAK PROFILE, KTS", I=xx, F=POINT')
289 DO 85 I = 1,NPTS
290 WRITE(IOU8,83) VHPK(I),ZZ(I)
291 85 CONTINUE
292 C
293 C WRITE(IOU8,86)
294 86 FORMAT( 1X,'ZONE T = "PEAK Q, PSF", I=xx, F=POINT')
295 DO 87 I = 1,NPTS
296 WRITE(IOU8,83) QHP(I),ZZ(I)
297 87 CONTINUE
298 C
299 C -----
300 C CLOSE GRAPHICS FILE
301 C -----
302 C
303 C CLOSE(IOU8,STATUS='KEEP')
304 C
305 C ENDIF
306 C
307 C CALL INKEY
308 C
309 C GOTO 999
310 C
311 C -----
312 C THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
313 C OPEN ERRORS BY RETURNING THE USER TO A MENU
314 C -----
315 C

```

SUBROUTINE IPVEL

```
316 2000 CONTINUE
317 C
318 CALL HOMCLS(0)
319 C
320 WRITE(IOU1,2001)
321 2001 FORMAT( //,8X,
322 1 ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME',
323 2 //,8X,' TYPE <RETURN> TO CONTINUE ', $)
324 C
325 READ(IOU1,'(A1)') TEMCHAR
326 C
327 KEY = 'P'
328 C
329 999 CONTINUE
330 C
331 RETURN
332 END
333 C
```

SUBROUTINE IREAD

```

1  C
2  C
3  SUBROUTINE IREAD(IOU1,PROMPT,IVALUE)
4  C
5  C *****
6  C SUBROUTINE IREAD PROMPTS USER FOR AN INTEGER
7  C DATA ENTRY AND CHECKS VALIDITY OF ENTRY
8  C *****
9  C
10 C
11 C
12 C
13 C
14 C
15 C DATA BLANK '/'
16 C
17 C *****
18 C
19 C -----
20 C PROMPT USER FOR INTEGER ENTRY. FIND POSITION
21 C OF LAST NON-BLANK CHARACTER IN PROMPT,
22 C THEN STORE RIGHT JUSTIFIED IN SHOWIT
23 C -----
24 C
25 C N = LAST + 1
26 C
27 C 10 IF(N.EQ.1)GOTO 20
28 C
29 C N = N - 1
30 C
31 C IF(PROMPT(N:N).EQ.' ')GOTO 10
32 C
33 C 20 JS = LAST - N
34 C
35 C WRITE(SHOWIT,'(50A1)') (' ',J=1,JS),(PROMPT(I:I),I=1,N)
36 C
37 C -----
38 C NOW ASK USER FOR DATA ENTRY
39 C -----
40 C
41 C 30 WRITE(IOU1,'(/,1X,A,I3)') SHOWIT,IVALUE
42 C
43 C WRITE(IOU1,'(/,8X,A,$)')
44 C 1 ' ENTER NEW VALUE OR <RETURN> TO LEAVE AS IS ==> '
45 C
46 C READ(IOU1,'(A)') ENTRY
47 C
48 C IF(ENTRY.EQ.BLANK)RETURN
49 C
50 C READ(ENTRY,'(BN,I7)',ERR=30) ITEMP
51 C
52 C IVALUE = ITEMP
53 C
54 C RETURN
55 C END
56 C

```

SUBROUTINE LEGAL

```

1  C
2  C
3  C      FUNCTION LEGAL(CHDOL, IOU1, OKLIST, NUM)
4  C
5  C      *****
6  C      FUNCTION LEGAL DETERMINES IF THE VALUE
7  C      FOR CHDOL IS A VALID INPUT.  THIS VALUE
8  C      IS CHECKED AGAINST THE LIST OF LEGAL
9  C      VALUE IN ARRAY OKLIST(NUM)
10 C      *****
11 C
12 C      CHARACTER*1 CHDOL, OKLIST(NUM)
13 C
14 C      *****
15 C
16 C      LEGAL = 0
17 C
18 C      DO 10 I=1, NUM
19 C      IF (CHDOL.EQ.OKLIST(I)) RETURN
20 C      10 CONTINUE
21 C
22 C      LEGAL = 1
23 C
24 C      WRITE(IOU1, '(/, T9, A, A1, A/)') ' *** ', CHDOL,
25 C      1 ' IS NOT A VALID INPUT ***'
26 C
27 C      RETURN
28 C      END
29 C

```


SUBROUTINE LOCATE

```

1  C
2  C
3  SUBROUTINE LOCATE (IROW, ICOL)
4  C
5  C *****
6  C SUBROUTINE LOCATE LOCATES THE CURSOR POSITION
7  C *****
8  C
9  COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
10 C
11 CHARACTER*8 CUP
12 CHARACTER*1 ECUP(8)
13 EQUIVALENCE (CUP, ECUP(1))
14 C
15 CHARACTER*10 FMT
16 CHARACTER*1 EFMT(10)
17 EQUIVALENCE (FMT, EFMT(1))
18 C
19 DATA FMT / ' (" ", A? \)' /
20 C
21 C *****
22 C
23 C -----
24 C ANSI CONTROL SEQUENCE: CUP = ESC['ROW'; 'COLUMN'H
25 C -----
26 C
27 IR1 = IROW/10
28 IR2 = IROW - IR1*10
29 IC1 = ICOL/10
30 IC2 = ICOL - IC1*10
31 C
32 ECUP(1) = CHAR(27)
33 ECUP(2) = CHAR(91)
34 IPOS = 3
35 C
36 IF (IR1.GT.0) THEN
37     ECUP(IPOS) = CHAR(IR1 + 48)
38     IPOS = IPOS + 1
39 ENDIF
40 C
41 ECUP(IPOS) = CHAR(IR2 + 48)
42 IPOS = IPOS + 1
43 C
44 ECUP(IPOS) = CHAR(59)
45 IPOS = IPOS + 1
46 C
47 IF (IC1.GT.0) THEN
48     ECUP(IPOS) = CHAR(IC1 + 48)
49     IPOS = IPOS + 1
50 ENDIF
51 C
52 ECUP(IPOS) = CHAR(IC2 + 48)
53 IPOS = IPOS + 1
54 C
55 ECUP(IPOS) = CHAR(72)
56 C
57 EFMT(7) = CHAR(IPOS + 48)
58 C
59 WRITE (IOU1, *) CUP
60 C
61 RETURN
62 END
63 C

```

SUBROUTINE MOMENT

```

1  C
2  C
3  SUBROUTINE MOMENT(NPTS,HUMTYP,TOTF,TOTM)
4  C
5  C *****
6  C SUBROUTINE MOMENT CALCULATES THE TOTAL OVERTURNING
7  C FORCE AND MOMENT ON A MAN OR YOUNG PERSON AND PRINTS
8  C OUT THE RESULTS.
9  C *****
10 C
11 CPAX    DIMENSION PAXMAN(12)
12        CHARACTER*1 HUMTYP
13 C
14        COMMON /PERSON/ QP(12),DSET
15        COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
16 C
17 C *****
18 C
19 C -----
20 C IN THE SUBROUTINE TO CALCULATE FORCES AND MOMENTS:
21 C
22 C     "CDP" IS THE COEFFICIENT OF DRAG OF THE PERSON:
23 C     CDP = 1.1 FOR HAZARD ANALYSES
24 C     CDP = 1.0 FOR CORRELATION WITH NATC FLIGHT TEST DATA
25 C     "WIDTHP" IS THE WIDTH OF THE PERSON WHERE:
26 C     WIDTHP IS 'L' TYPE IF 1.1 FT
27 C     WIDTHP IS 'S' TYPE IF 0.7 FT
28 C     -----
29 C
30     WIDTHP = 1.1
31     CDP    = 1.1
32 C
33 C -----
34 C INITIALIZE AREAS FOR NATC MAN FROM ROTORWASH FLIGHT TESTS
35 C (UNITS ARE FEET2)
36 C -----
37 C
38 CPAX    CDP    = 1.1
39 CPAX    PAXMAN(1) = 0.41
40 CPAX    PAXMAN(2) = 0.37
41 CPAX    PAXMAN(3) = 0.365
42 CPAX    PAXMAN(4) = 0.42
43 CPAX    PAXMAN(5) = 0.5425
44 CPAX    PAXMAN(6) = 0.685
45 CPAX    PAXMAN(7) = 0.8
46 CPAX    PAXMAN(8) = 0.845
47 CPAX    PAXMAN(9) = 0.7875
48 CPAX    PAXMAN(10) = 0.625
49 CPAX    PAXMAN(11) = 0.3
50 CPAX    PAXMAN(12) = 0.00625
51 C
52 C -----
53 C INITIALIZE INTEGRATION STEP SIZE AND ZERO SUMMATION VARIABLES
54 C -----
55 C
56     DELZZ = 0.5
57     TOTM  = 0.0
58     TOTF  = 0.0
59 C
60 C -----
61 C CHOOSE HUMAN SIZE TYPE
62 C -----
63 C

```

SUBROUTINE MOMENT

```

64      IF (HUMTYP.EQ.'S') THEN
65          WIDTHP = 0.7
66          NPTS   = 8
67      END IF
68      C
69      C -----
70      C INTEGRATE DYNAMIC PRESSURE PROFILE OVER
71      C THE HEIGHT OF THE PERSON CHOSEN
72      C -----
73      C
74      DO 10 J = 1,NPTS
75      C
76          FOVER = QP(J)*DELZZ*WIDTHP*CDP
77      CPAX      FOVER = QP(J)*PAXMAN(J)*CDP
78          ZZ    = 0.5*(J - 1) + 0.25
79          OVERM = FOVER*ZZ
80          TOTF  = TOTF + FOVER
81          TOTM  = TOTM + OVERM
82      C
83      C -----
84      C PRINT OUT RESULTS
85      C -----
86      C
87      IF (DSET.NE.0.) GOTO 10
88      C
89      WRITE (YOU6,20) ZZ, QP(J), FOVER, OVERM, TOTF, TOTM
90      20 FORMAT( F9.2, 5(2X, F10.3))
91      C
92      10 CONTINUE
93      C
94      RETURN
95      END
96      C
97

```

SUBROUTINE PROPRM

```

1  C
2  C
3      SUBROUTINE PROPRM(H,UMB,RVZ)
4  C
5  C
6  *****
7  C      SUBROUTINE PROPRM
8  C
9  C      THIS SUBROUTINE CALCULATES THE VELOCITY PROFILE V(R,Z)
10 PARAMETERS
11 C      OF THE RADIAL WALL JET FOR THE NON-INTERACTING ROTOR CASE
12 C
13 *****
14 C
15     COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
16 C
17 C
18 *****
19 C
20     IF(RVZ.GE.RJ)GOTO 600
21 C
22 C -----
23 C     RVZ .LT. RJ ==> TRANSITION REGION
24 C
25 C     TRANSITION REGION EQUATIONS, EMPIRICALLY APPLIED BY
26 C     JDK PRIOR TO VERSION 2.1, WERE SIGNIFICANTLY IMPROVED
27 C     BY THE FOLLOWING CHANGES FOR V2.1 IN MAY 1992.
28 C
29 C     OLD OR REPLACED EQUATIONS:
30 C
31 C         UM = UMJ*RVZ
32 C         IF(RVZ.GT.1.0) UM = UMJ
33 C         ZH = ZHJ*RVZ
34 C         IF(RVZ.GT.1.0) ZH = ZHJ
35 C         ZM = ZMJ*RVZ
36 C         IF(RVZ.GT.1.0) ZM = ZMJ
37 C -----
38 C
39     UM = UMJ*(RVZ/RJ)**0.5
40 C
41 C -----
42 C     BOUNDARY GROWTH IN TRANSITION REGION
43 C
44 C     SEE NOTE ABOVE
45 C
46 C     OLD OR REPLACED EQUATIONS:
47 C
48 C         ZB0 = 1.5
49 C         IF(H.LT.1.5) ZB0 = H
50 C         ZH = (ZH0 - ZHJ)/RJ**2*(RJ - RVZ)**2 + ZHJ
51 C -----
52 C
53     ZB0 = H**0.5
54     ZH0 = ZB0/2.5
55 C
56     ZH = (ZH0 - ZHJ)/RJ**2*(RJ - RVZ)**1.5 + ZHJ
57     ZB = 2.5*ZH
58     ZM = 0.33*ZH
59 C
60     GOTO 700
61 C
62 C -----
63 C     RVZ .GE. RJ ==> DEVELOPED WALL JET REGION

```

SUBROUTINE PROPRM

```

64 C
65 C      SEVERAL COEFFICIENTS IN THE GROWTH EQUATIONS
66 C      WERE MODIFIED IN MAY 1992 FOLLOWING THE
67 C      CORRELATION EFFORT (SEE NOTES IN SUBROUTINE
68 C      WALJET FOR DETAILS) .
69 C
70 C      OLD EQUATIONS:
71 C
72 C          UM = CU*RVZ**(-1.143)*UMB
73 C          ZH = CY*RVZ**(1.028)
74 C          ZM = 0.1944*ZH
75 C      -----
76 C
77 C      600 CONTINUE
78 C
79 C          UM = CU*RVZ**(-1.0)*UMB
80 C          ZH = CY*RVZ**(1.0)
81 C          ZB = 2.8*ZH
82 C          ZM = 0.28*ZH
83 C
84 C      700 CONTINUE
85 C
86 C          RETURN
87 C          END
88 C

```

SUBROUTINE VLINE

```

1  C
2  C
3  SUBROUTINE VLINE
4  C
5  C
6  *****
7  C    SUBROUTINE VLINE
8  C
9  C    THIS SUBROUTINE APPLIES THE BIOT-SAVORT LAW TO
10 C    CALCULATE THE VELOCITY INDUCED BY A LINE VORTEX
11 C
12 C    XA,YA,ZA = STARTING POINT OF VORTEX
13 C    XB,YB,ZB = ENDING POINT, OR DIRECTION POINTER
14 C    XC,YC,ZC = TARGET POINT WHERE VELOCITY IS INDUCED
15 C
16 C    IFI = 0    VORTEX IS FINITE, FROM POINT A TO POINT B
17 C    IFI = 1    VORTEX IS SEMI-INFINITE FROM POINT A THROUGH B
18 C
19 C
20 *****
21 C
22 C    COMMON /CONSTS/ PI,RHO,FPSPKN,RHOD2,DRC
23 C    COMMON /CVLINE/ IFI,XA,YA,ZA,XB,YB,ZB,XC,YC,ZC,Q1,Q2,Q3
24 C
25 C
26 *****
27 C
28 C    A = (XA-XC)**2 + (YA-YC)**2 + (ZA-ZC)**2
29 C    B = 2.0*( (XA-XB)*(XC-XA) + (YA-YB)*(YC-YA) + (ZA-ZB)*(ZC-ZA)
30 C
31 C    C = (XA-XB)**2 + (YA-YB)**2 + (ZA-ZB)**2
32 C
33 C    C1 = (YC-YB)*ZA + (YA-YC)*ZB + (YB-YA)*ZC
34 C    C2 = (ZC-ZB)*XA + (ZA-ZC)*XB + (ZB-ZA)*XC
35 C    C3 = (XC-XB)*YA + (XA-XC)*YB + (XB-XA)*YC
36 C
37 C    Q = 4.0*A*C - B**2
38 C
39 C    -----
40 C    CHECK FOR COLINEAR TARGET POINT
41 C    -----
42 C
43 C    QB = 0.0
44 C    IF (ABS(Q).LT.1.0E-06) GOTO 100
45 C
46 C    -----
47 C    FINITE LENGTH VORTEX
48 C    -----
49 C
50 C    IF (IFI.EQ.0) THEN
51 C        QB = 1.0/Q*((2.0*C + B)/SQRT(A + B + C) - B/SQRT(A))/2.0/PI
52 C    ENDIF
53 C
54 C    -----
55 C    SEMI-INFINITE VORTEX
56 C    -----
57 C
58 C    IF (IFI.EQ.1) THEN
59 C        QB = 1.0/Q*(2.0*SQRT(C) - B/SQRT(A))/2.0/PI
60 C    ENDIF
61 C
62 C    100 CONTINUE
63 C

```

SUBROUTINE VLINE

```
64 C -----  
65 C VELOCITY COMPONENTS  
66 C -----  
67 C  
68 Q1 = C1*QB  
69 Q2 = C2*QB  
70 Q3 = C3*QB  
71 C  
72 RETURN  
73 END  
74 C
```

SUBROUTINE WALJET

```

1  C
2  C
3  SUBROUTINE WALJET (H,UB,UN,UMB)
4  C
5  C
6  *****
7  C    SUBROUTINE WALJET
8  C
9  C    THIS SUBROUTINE CALCULATES THE STARTING POSITION OF THE
10 C    WALL JET AND GROWTH PARAMETERS FOR WALL JET DECAY
11 C
12 C    *****
13 C
14 C    COMMON /CLOUDK/ QSMAX
15 C    COMMON /PROFIL/ RJ,ZBJ,ZHJ,ZMJ,UMJ,ZB,ZH,ZM,UM,CU,CY
16 C    COMMON / UNITS/ IOU1,IOU4,IOU5,IOU6,IOU7,IOU8,IGRAPH
17 C
18 C
19 C    *****
20 C
21 C    -----
22 C    INITIALIZATION OF EXPONENTS
23 C
24 C    CZM, THE PROFILE PEAK VELOCITY LOCATION, WAS INCREASED
25 C    FROM THE GLAUERT VALUE (0.1944) TO THE PRESENT VALUE
26 C    BASED ON DATA AND ASSUMPTIONS PRESENTED IN FAA REPORT
27 C    FOR VERSION 2.1, MAY 1992. THE OTHER COEFFICIENTS WERE
28 C    MODIFIED WHEN IT WAS DEMONSTRATED THAT CORRELATION WAS
29 C    IMPROVED WITH BOTH MODEL AND FLIGHT TEST DATA.
30 C
31 C    VARIABLE      VALUE FOR V2.1    BEFORE V2.1
32 C
33 C    EXU            -1.0              -1.143
34 C    EXY            1.0              1.028
35 C    CZM            0.28             0.1944
36 C    QSMAX0         1.077            1.0    (SEE NOTE BELOW)
37 C    -----
38 C
39 C    EXU = -1.0
40 C    EXY = 1.0
41 C    EXM = 1.0 + EXU + EXY
42 C    CZM = 0.28
43 C    CZB = 2.8
44 C
45 C    -----
46 C    ITERATE TO FIND INITIAL RADIUS OF WALL JET, RJ
47 C    -----
48 C
49 C    TOL = 1.0E-05
50 C    RJ = 2.0
51 C
52 C    QSMAX0 = 1.077
53 C
54 C    DO 100 I=1,20
55 C
56 C    -----
57 C    CALCULATION OF EQUIVALENT JET LENGTH
58 C    -----
59 C
60 C    TR = H + (RJ - 1.0)
61 C    IDE = 0.707*TR
62 C
63 C    -----

```


SUBROUTINE WALJET

```

64 C QSMAX CURVEFIT ORIGINALLY TO FIG. 8, USAAVLABS TECHNICAL
65 C REPORT 68-52, JULY 1968. UPDATED INFORMATION FROM FIG. 2,
66 C REPORT DTNSRDC/ASED-79/04, APRIL 1979.
67 C
68 C OLD TR 68-52 EQUATIONS:
69 C
70 C QSMAX0 = 1.0
71 C IF (TDE.LE.4.0) QSMAX = QSMAX0 + (0.6 - QSMAX0)/16.0*TDE**2
72 C IF (TDE.GT.4.0) QSMAX = 2.4/TDE
73 C
74 C RJNEW COEFFICIENTS ROUNDED OFF DURING MAY 1992 CORRELATION
75 C EFFORT WHICH PRODUCED IMPROVED RESULTS WHEN SIMPLIFICATIONS
76 C WERE INTRODUCED
77 C
78 C OLD EQUATION:
79 C
80 C RJNEW = 2.508078*(UB/UM)**(0.486)
81 C -----
82 C
83 C IF (TDE.LE.3.5) QSMAX = 1.08 - 0.025*TDE**2
84 C IF (TDE.GT.3.5) QSMAX = 2.7/TDE
85 C
86 C UM = SQRT(QSMAX)
87 C
88 C RJNEW = 2.5*(UB/UM)**(0.5)
89 C
90 C IF (ABS(RJNEW - RJ).LE.TOL)GOTO 200
91 C RJ = RJNEW
92 C
93 C 100 CONTINUE
94 C
95 C WRITE(10U1,10)
96 C 10 FORMAT('*****',/
97 C 1 , 'ITERATIONS EXCEEDED FOR WALL JET INITIAL RADIUS',/
98 C 2 , '*****')
99 C
100 C STOP ' '
101 C
102 C 200 CONTINUE
103 C
104 C RJ = RJNEW
105 C
106 C -----
107 C VELOCITY GROWTH FUNCTION CONSTANTS
108 C
109 C TWO CONSTANTS WERE ROUNDED OFF TO SIMPLIFY THE FOLLOWING
110 C TWO EQUATIONS DURING THE CORRELATION EFFORT OF MAY 1992
111 C FOR VERSION 2.1
112 C
113 C OLD EQUATIONS:
114 C
115 C UMB = ((0.3586*RJ**EXM*(UM*UN)*(UB*UN)**(0.14))**(0.88))/UN
116 C ZHJ = 0.654/(UM/UMB)**2/RJ
117 C -----
118 C
119 C UMB = ((0.36*RJ**EXM*(UM*UN)*(UB*UN)**(0.14))**(0.88))/UN
120 C ZHJ = 0.65/(UM/UMB)**2/RJ
121 C CU = UM/UMB*RJ**(-EXU)
122 C CY = ZHJ*RJ**(-EXY)
123 C
124 C -----
125 C MAX VELOCITY AND BOUNDARY PARAMETERS AT RJ
126 C -----

```

SUBROUTINE WALJET

```
127 C
128   UMJ = CU*RJ** (EXU) *UMB
129   ZHJ = CY*RJ** (EXY)
130   ZMJ = CZM*ZHJ
131   ZBJ = CZB*ZHJ
132 C
133   RETURN
134   END
135 C
```

SUBROUTINE WJVEL

```

1  C
2  C
3  SUBROUTINE WJVEL (H, UN, UMB, RVZ, RADIUS, WSPD, DELZ, ZMAX, DXO, BDLAYM)
4  C
5  C *****
6  C SUBROUTINE WJVEL GENERATES THE VELOCITY PROFILE V(R, Z)
7  C AT RVZ FOR THE NON-INTERACTING ROTOR CASE
8  C *****
9  C
10 CHARACTER*1 TEMCHAR
11 CHARACTER*1 ICONT(5)
12 CHARACTER*1 KEY, KKEY
13 CHARACTER*12 PTSFIL(4)
14 CHARACTER*50 COMM(2)
15 C
16 DIMENSION ZZ(60), VMF(60), VMK(60), VPF(60),
17 1 VPK(60), QM(60), QP(60)
18 C
19 COMMON / CKEY/ KEY, KKEY
20 COMMON /CONSTS/ PI, RHO, FPSPKN, RHOD2, DRC
21 COMMON /INPUTC/ ICONT, COMM, PTSFIL
22 COMMON /PROFIL/ RJ, ZBJ, ZHJ, ZMJ, UMJ, ZB, ZH, ZM, UM, CU, CY
23 COMMON / UNITS/ IOU1, IOU4, IOU5, IOU6, IOU7, IOU8, IGRAPH
24 C
25 C *****
26 C
27 C -----
28 C 'PROPRM' PROVIDES THE VELOCITY PROFILE PARAMETERS
29 C OF A RADIAL WALL JET (WITHOUT INTERACTION PLANE)
30 C -----
31 C
32 CALL PROPRM(H, UMB, RVZ)
33 C
34 C -----
35 C DIMENSIONALIZE VELOCITY PROFILE PARAMETERS
36 C -----
37 C
38 RRZVZ = RADIUS*RVZ
39 ZZB = ZB*RADIUS
40 ZZH = ZH*RADIUS
41 ZZM = ZM*RADIUS
42 C
43 ZETAH = ZH/ZB
44 ZETAM = ZM/ZB
45 C
46 C -----
47 C OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
48 C -----
49 C
50 ICD = 0
51 CALL HOMCLS(ICD)
52 IF(IOU6.NE.IOU1) WRITE(IOU6, ' (''1'')' )
53 C
54 IF(IOU6.EQ.6) WRITE(IOU6, 93) COMM(1), COMM(2)
55 93 FORMAT( 10X, A50, /, 10X, A50, /)
56 C
57 RVZOUT = RRZVZ + DXO
58 C
59 WRITE(IOU6, 1000) RVZOUT
60 1000 FORMAT( 9X, 'SINGLE ROTOR VELOCITY PROFILE AT RADIUS = ',
61 1 F7.1, ' FT', /)
62 C
63 WRITE(IOU6, 1001) ZZB, ZZH, ZZM

```

SUBROUTINE WJVEL

```

64 1001 FORMAT( 15X,'PROFILE BOUNDARY HEIGHT = ',F7.2,' FT',/
65 1      ,15X,'      HALF-VEL.HEIGHT = ',F7.2,' FT',/
66 2      ,15X,'      MAX-VEL HEIGHT = ',F7.2,' FT',/)
67 C
68 C -----
69 C INCREMENTS AND HEIGHT ARE FROM DELZ AND ZMAX
70 C -----
71 C
72 NPTS = IFIX(ZMAX/DELZ) + 1
73 C
74 C -----
75 C BOUNDARY LAYER REGION EXPONENT
76 C 'AN' IS ACTUALLY = 1.0/7.0
77 C -----
78 C
79 AN = 0.142857142
80 C
81 C -----
82 C SHEAR LAYER REGION EXPONENT, TO MEET EDGE CONDITIONS
83 C (FROM FIGURE 7, USAAVLABS TECHNICAL REPORT 68-52, JULY 1968)
84 C -----
85 C
86 ALPW = ALOG(1.0 - 1.0/SQRT(2.0))/ALOG((ZH - ZM)/(ZB - ZM))
87 C
88 VN = UN
89 VMN = UM
90 C
91 C -----
92 C CALCULATION OF THE NON-DIMENSIONALIZED MINIMUM ALLOWED
93 C BOUNDARY LAYER THICKNESS SO THAT THE BOUNDARY LAYER CAN
94 C BE ADJUSTED IF THE ZM POSITION IS PHYSICALLY TOO LOW
95 C (BDLAYM, IN FEET, COMES FROM A MENU INPUT PARAMETER)
96 C -----
97 C
98 ZETA1 = BDLAYM/ZB
99 C
100 C -----
101 C OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILE HEADER
102 C -----
103 C
104 WRITE(1006,1005)
105 1005 FORMAT( 2X,'HEIGHT',5X,'MEAN VELOCITY',7X,'PEAK VELOCITY',6X,
106 1      'MEAN Q',4X,'PEAK Q',/,
107 2      3X,' (FT)',5X,' (FPS)',6X,' (KN)',5X,' (FPS)',6X,' (KN)',5X,
108 3      ' (PSF)',5X,' (PSF)',/)
109 C
110 C -----
111 C CALCULATE THE VELOCITY PROFILE POINTS FOR OUTPUT
112 C -----
113 C
114 LINES = 0
115 C
116 DO 500 I = 1,NPTS
117 C
118 LINES = LINES + 1
119 Z = DELZ*FLOAT(I - 1)
120 ZETA = Z/ZB
121 C
122 IF (ZETA.LT.ZETAM.OR.ZETA.LT.ZETA1) THEN
123 C
124 C -----
125 C Z IS WITHIN BOUNDARY LAYER
126 C

```

SUBROUTINE WJVEL

```

127 C      NOTE THAT THE BOUNDARY LAYER CALCULATIONS NOW USE
128 C      THE MINIMUM THICKNESS PARAMETER AND THE PEAK TO
129 C      MEAN VELOCITY PARAMETER IS THE MAXIMUM VELOCITY
130 C      HEIGHT RATIO (AT ZM).  ADDED MAY 1992 FOR V2.1.
131 C      -----
132 C
133 C      VZM = 0.0
134 C
135 C      IF (ZETAM.GT.0.0) THEN
136 C
137 C          VZM = (ZETA/ZETAM)**AN
138 C
139 C          IF (ZETA1.GT.ZETAM) THEN
140 C
141 C              VZM1 = (1.0 - ((ZETA1 - ZETAM)/(1.0 - ZETAM))**ALPW)**2
142 C              VZM = VZM1*(ZETA/ZETA1)**AN
143 C
144 C          ENDIF
145 C
146 C          VMTOPK = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
147 C
148 C          IF (VMTOPK.LT.1.2) VMTOPK = 1.2
149 C
150 C      ENDIF
151 C
152 C      GOTO 400
153 C
154 C  ENDIF
155 C
156 C      -----
157 C      Z IS WITHIN SHEAR LAYER
158 C
159 C      THE PEAK TO MEAN VELOCITY RATIO EQUATIONS ARE
160 C      SUBSTANTIALLY IMPROVED OVER THOSE USED PRIOR TO
161 C      MAY 1992.  EQUATIONS ARE NOW USED FOR BOTH THE
162 C      MAXIMUM VELOCITY HEIGHT (ZM) AND THE 1/2 VELOCITY
163 C      HEIGHT (ZH).  VALUES BETWEEN ARE INTERPOLATED AND
164 C      VALUES ABOVE ZH USE THE ZH RATIO*(ZETA/ZETAH).
165 C      THESE 2nd ORDER EQUATION SUBSTANTIALLY IMPROVED
166 C      CORRELATION WITH MODEL AND FLIGHT TEST DATA
167 C      DURING THE MAY 1992 EFFORT FOR V2.1.
168 C      -----
169 C
170 C      VZM = 0.0
171 C
172 C      IF (Z.LE.ZB) THEN
173 C
174 C          VZM = (1.0 - ((ZETA - ZETAM)/(1.0 - ZETAM))**ALPW)**2
175 C
176 C          IF (ZETA.GE.ZETAH) THEN
177 C
178 C              VMTOPK = (1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ)
179 C                  1      *(ZETA/ZETAH)
180 C
181 C              IF (VMTOPK.LT.1.2) VMTOPK = 1.2
182 C
183 C          ELSE
184 C
185 C              VMPKMX = 1.04653 + 0.373894*RVZ - 0.0422525*RVZ*RVZ
186 C
187 C              VMPK12 = 1.48086 + 0.569177*RVZ - 0.0692514*RVZ*RVZ
188 C
189 C              FRAC = (ZETA - ZETAM)/(ZETAH - ZETAM)

```

SUBROUTINE WJVEL

```

190 C
191     IF(ZETA1.GT.ZETAM) THEN
192 C
193         FRAC  = (ZETA - ZETA1)/(ZETAH - ZETA1)
194 C
195     ENDIF
196 C
197     VMTOPK = FRAC*VMPK12 + (1.0 - FRAC)*VMPKMX
198 C
199     IF(VMTOPK.LT.1.2) VMTOPK = 1.2
200 C
201     ENDIF
202 C
203     ENDIF
204 C
205 400 CONTINUE
206 C
207     VZN = VZM*VMN
208 C
209 C -----
210 C DIMENSIONAL HEIGHT
211 C -----
212 C
213     ZZ(I) = Z*RADIUS
214 C
215 C -----
216 C MEAN VELOCITIES
217 C -----
218 C
219     VMF(I) = VZN*VN
220     VMK(I) = VMF(I)/FPSPKN
221 C
222 C -----
223 C PEAK VELOCITIES
224 C -----
225 C
226     VPF(I) = VMF(I)*VMTOPK
227     VPK(I) = VPF(I)/FPSPKN
228 C
229     IF(VPK(I).EQ.0.0) GOTO 55
230 C
231 C -----
232 C THE EFFECT OF WIND IS TO ADD (DOWNWIND SIDE) OR SUBTRACT
233 C (UPWIND SIDE) 'XKW' TIMES THE AMBIENT WIND VELOCITY TO
234 C THE HORIZONTAL PROFILE VELOCITY (EMPIRICAL, CH-53E BASED)
235 C -----
236 C
237     XKW = (-0.5*H) + 2.5
238 C
239     IF(XKW.LT.1.0) XKW = 1.0
240 C
241     WSPD2 = WSPD*XKW
242     VMK(I) = VMK(I) + WSPD2
243     VMF(I) = VMK(I)*FPSPKN
244     VPK(I) = VPK(I) + WSPD2
245     VPF(I) = VPK(I)*FPSPKN
246 C
247 55 CONTINUE
248 C
249 C -----
250 C DYNAMIC PRESSURE
251 C -----
252 C

```

SUBROUTINE WJVEL

```

253      QM(I) = RHOD2*VMF(I)**2
254      QP(I) = RHOD2*VPF(I)**2
255  C
256      IF(IOUS.EQ.IOUS1) THEN
257          IF(LINES.LT.12) GOTO 450
258          LINES = 1
259          CALL INKEY
260          IF(KEY.NE.'C') GOTO 999
261          WRITE(IOUS,1005)
262      ENDIF
263  C
264      450  CONTINUE
265  C
266  C      -----
267  C      OUTPUT THE VELOCITY AND DYNAMIC PRESSURE PROFILES
268  C      -----
269  C
270      WRITE(IOUS,1002) ZZ(I),VMF(I),VMK(I),VPF(I),
271      *      VPK(I),QM(I),QP(I)
272      1002  FORMAT( F8.2,6F10.3)
273  C
274      500  CONTINUE
275  C
276  C      -----
277  C      WRITE OUT GRAPHICS FILES IF SWITCH IS SET BY USER
278  C      -----
279  C
280      IF(IGRAPH.EQ.1) THEN
281  C
282  C      -----
283  C      OPEN GRAPHICS FILE
284  C      -----
285  C
286      OPEN(IOUS,FILE=PTSFIL(1),STATUS='NEW',ERR=2000)
287  C
288      WRITE(IOUS,89) COMM(1),COMM(2)
289      89  FORMAT( 10X,A50,/,10X,A50,/)
290  C
291      WRITE(IOUS,80) RVZOUT
292      80  FORMAT( 1X,'TITLE="VELOCITY PROFILE, DFERC =',F5.1,' FT,'
293      *      ' GW = xxxxx LB, WAGL = xx.x FT"')
294  C
295  C      -----
296  C      PRINT OUT MEAN VELOCITY, PEAK VELOCITY, AND PEAK
297  C      DYNAMIC PRESSURE PROFILES VERSUS PROFILE HEIGHT (AGL)
298  C      -----
299  C
300      WRITE(IOUS,88)
301      88  FORMAT( 1X,'VARIABLES = X,HT')
302  C
303      WRITE(IOUS,81)
304      81  FORMAT( 1X,'ZONE T = "MEAN PROFILE, KTS", I=xx, F=POINT')
305  C
306      DO 82 I = 1,NPTS
307          WRITE(IOUS,83) VMK(I),ZZ(I)
308          83  FORMAT( 1X,F6.1,1X,F6.2)
309          92  CONTINUE
310  C
311      WRITE(IOUS,84)
312      84  FORMAT( 1X,'ZONE T = "PEAK PROFILE, KTS", I=xx, F=POINT')
313  C
314      DO 85 I = 1,NPTS
315          WRITE(IOUS,83) VPK(I),ZZ(I)

```

SUBROUTINE WJVEL

```

316      85  CONTINUE
317  C
318      WRITE(IOU8,86)
319      86  FORMAT( 1X,'ZONE T = "PEAK Q, PSF", I=xx, F=POINT')
320  C
321      DO 87 I = 1,NPTS
322      WRITE(IOU8,83) QP(I),ZZ(I)
323      87  CONTINUE
324  C
325  C      -----
326  C      CLOSE GRAPHICS FILE
327  C      -----
328  C
329      CLOSE(IOU8,STATUS='KEEP')
330  C
331      ENDIF
332  C
333      CALL INKEY
334  C
335      GOTO 999
336  C
337  C      -----
338  C      THE ERROR LOGIC ALLOWS FOR THE HANDLING OF FILE
339  C      OPEN ERRORS BY RETURNING THE USER TO A MENU
340  C      -----
341  C
342      2000 CONTINUE
343  C
344      CALL HOMCLS(0)
345      WRITE(IOU1,2001)
346      2001 FORMAT( ////,8X,
347      1      ' *** ERROR *** PLEASE CHOOSE A NEW OUTPUT FILENAME'
348      2      //,8X,'          TYPE <RETURN> TO CONTINUE ',S)
349      READ(IOU1,'(A1)') TEMCHAR
350      KEY = 'P'
351  C
352      999 CONTINUE
353  C
354      RETURN
355      END
356  C
357

```

END